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THE CHALLENGE OF DEVELOPING A FLEET DRIVING RISK ASSESSMENT TOOL: WHAT CAN BE LEARNED FROM THE PROCESS?

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Abstract

Considering the over representation of work related crashes and injuries involving the operation of motor vehicles while undertaking work activities, driving for work has been identified as one of the riskiest activities in the course of a person's work (Mitchell, Friswell, & Mooren, 2012; WHO, 2004; Haworth, Tingvall, & Kowadlo, 2000; Wishart, Rowland, Freeman, & Davey, 2011). Researchers in attempting to better understand work driving behaviour have utilised a variety of popular self-report measures such as Driver Behaviour Questionnaire (Reason et al., 1990), Driver Attitude Questionnaire (Parker et al., 1995); and the Safety Climate Questionnaire (Glendon & Litherland, 2001).

Despite legislative requirements clearly outlining obligations associated with work vehicle use and risk management, many organisations fail to adequately address risks associated with work driving consideration (Haworth et al, 2008, Stuckey et al, 2007; Davey et al., 2008; Wishart et al., 2004; Wishart & Davey, 2004). One of the potential reasons organisations fail in risk assessment and management processes within the Australian light vehicle fleet setting, may be due to the distinct lack of work-related driving risk measurement tools to assist organisations in assessing work driving risk. The overarching aim of this thesis by published papers is to contribute to the safety of those who drive for work purposes by developing and testing a new work driving risk assessment measurement tool for use by organisations.

The program of research can be conceptualised as three stages with each stage incorporating one or more published papers arising from an empirical study. The first stage of the research investigated the ability of previously designed self-report measurement tools to predict work related driving risk within Australian light vehicle fleet settings.

Paper One, reports on a study utilising three previously designed measures, the Driver Behaviour Questionnaire, Driver Attitude Questionnaire and the Safety Climate Scale Modified for Drivers, to a large sample (4195) of work drivers within Australia to determine the suitability of each of these measures to predict risky driving behaviour. The results indicated that other than driving exposure

operationalized as an estimate of annual kilometres travelled, only the Driver Behaviour Questionnaire Factor of Errors (Reason et al., 1990), and the Safety Climate Questionnaire Modified for Drivers factors of perceived work pressure (Wills et al., 2006: Glendon & Litherland, 2001) predicted crash involvement. However, while these results appear encouraging, the overall model is not very efficient at predicting drivers involved in crashes.

Paper Two, was designed to extend upon study one, and utilised the Driver Behaviour Questionnaire (Reason et al., 1990) and incorporated a number of additional items designed to represent various organisational and contextual issues associated with work driving within the Australian context. This study administered the questionnaire to 443 individuals driving light vehicles within an Australian organisational fleet setting. Consistent with the study reported in the first paper driving exposure was predictive of self-reported risky driving outcomes. However, in contrast to the previous study the Driver Behaviour Questionnaire factors of Errors (Reason et al., 1990) failed to be associated with risky driving behaviours, rather a new factor representative of fatigue and distraction was associated with self-reported traffic offences.

Overall, the results reported in Paper's One and Two provided little evidence of the ability of previously designed self-report measures to accurately predict risky driving behaviour outcomes such as crashes and traffic offences within the Australian light vehicle fleet settings. The results also suggest that a variety of other factors not incorporated within these previously designed measures may be involved in influencing work driving behaviour.

Paper Three, represented the second stage of the research program, which involved a qualitative study designed to identify other potential factors of influence to Australian work driving behaviour. This study utilised focus groups to investigate 217 drivers' perceptions regarding what influences their driving behaviour within the Australian organisational driving context. The results obtained from this study although identifying a range of influences on driver behaviour consistent with current road safety initiatives, also identified a variety of additional factors that appear to influence work related driving behaviour particularly within Australian fleet drivers. Importantly, this research highlighted the potential for factors to have a bidirectional influence on driver behaviour. For example, a number of factors identified such as

adverse road conditions or safer vehicles, demonstrated the potential to influence some drivers in a positive and safe manner while the same factors were identified as influencing other drivers in a completely opposite manner in regards to driving safely for work. The results of this study were utilised to aid in the development of a newly designed work driving risk assessment measure examined within the third stage of the research program.

The third stage of the research program incorporates two publications designed to address the second and third objectives of the research. Paper Four was included in response to the increased development and activity associated with work related road safety and risk assessment around the world since the commencement of the current thesis. This paper highlights particular difficulties and issues experienced by other researchers in the development of self-report work driving assessment measures since the start of the current program of research. This contextual paper addresses the third objective of the research by identifying current and emerging issues impacting upon the development of self-report driving risk assessment measures within the work driving setting. Upon outlining various limitations of self-report work driving risk measurement tools, this paper informs the final stage of driving risk assessment measurement development within this thesis. In particular this paper highlights the importance of adopting a stronger focus on the development and inclusion of items reflecting organisational related issues and influences, as opposed to the primarily driver related issues and influences focussed on by previous measures.

The fifth paper reports on the administration and results of a newly devised 38 item contemporary occupational driving risk assessment scale to a sample of 546 work drivers from organisations within Queensland, Australia. The purpose of this study was to address the fourth objective of this thesis by investigating the ability of a newly devised self-report work driving risk assessment measure to predict crashes and offences within the Australian light vehicle fleet context. Along with incorporating some items from previous measures such as speeding and aggression, this measure included items designed to assess other organisational related issues such as time pressure, distraction, vehicle maintenance, and fatigue. The results indicated that, despite the overall measure displaying a reasonably sound factor structure, and the overall model indicating statistical significance, the accuracy of the

model or any constructs within it to accurately predict crashes or offences was extremely limited. Consequently, the new measure proved to be no more efficient in predicting self-reported risky driving than other previously utilised self-report measures.

Overall, the current research program provided evidence that the work driving environment is extremely complex and involves constant interactions between humans, vehicles, the road environment, and the organisational context. In addition, the results from studies within this thesis indicated that within the Australian work driving context, the Driver Behaviour Questionnaire, despite its popularity, along with other self-report measures demonstrate a distinct lack of effectiveness in predicting risky driving behaviour as assessed by self-report crashes and offences.

Consequently, future work driving risk assessment research will need to utilise various sources of data such as in vehicle technology, self-report, and official crash databases to ensure development of valid outcome measures associated with risky work driving behaviour. In addition, future work driving risk assessment measure development may have to adopt a tailored and comprehensive organisational approach, particularly focussing on organisational level processes and procedures that influence the driving safety of at work drivers.

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List of Abbreviations

ABS - Anti-lock Braking System

AFMA - Australasian Fleet Management Association

ANCAP - Australasian New Car Assessment Program

AS/NZS - Australian and New Zealand Standard

DAQ - Driver Attitude Questionnaire

DBQ - Driver Behaviour Questionnaire

4WD - Four Wheel Drive

GPS - Global Positioning System

IVMS – In vehicle monitoring system

OHS - Occupational Health and Safety

OLV - Occupational Light Vehicle

SCQ - Safety Climate Questionnaire

SCQMD - Safety Climate Questionnaire Modified for Drivers

SUV - Sport Utility Vehicle

WHO - World Health Organisation

WHS - Workplace Health and Safety

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

Date: 12 March 2015

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Chapter 1: Introduction to Thesis

1.1 INTRODUCTORY COMMENTS

Driving for work is potentially one of the riskiest activities undertaken in the course of a person's work, which is evidenced by the over representation of work related crashes and injuries involving the operation of motor vehicles while undertaking work activities (Mitchell, Friswell, & Mooren, 2012; WHO, 2004; Haworth, Tingvall, & Kowadlo, 2000; Wishart, Rowland, Freeman, & Davey, 2011). Accordingly, work related road safety is an area within road safety that is gaining increased attention due to the substantial physical, emotional, and economic costs to the community that are associated with work related road crashes. For instance, research over an extended period of time has demonstrated that work-related drivers are consistently involved in a higher level of crash involvement in comparison to private car drivers (Australian Transport Council, 2011; Downs, Keigan, Maycock, & Grayson, 1999; Lynn & Lockwood, 1998). In fact, recent figures reported in the National Road Safety Strategy 2011-2020 highlight that within Australia, company drivers' travel twice the annual distance and have approximately 50% more crashes than drivers of private vehicles (Australian Transport Council, 2011). Previous research has also shown that road crashes are the most common form of work related fatalities (Haworth, et al., 2000) and overall, work related crashes account for approximately half of all occupational fatalities (Safe Work Australia, 2009). Furthermore, earlier research suggests that work related road crash injuries are also approximately twice as likely to result in death or permanent disability as other workplace injuries (Wheatley, 1997) and the average time lost due to injury is greater than any other workplace claim (Stewart-Bogle, 1999).

Previous research has also found that work related road fatalities account for up to 23% of all work related fatalities in Australia and 13% of the national road toll (Murray, Newnam, Watson, Davey, Schonfeld, 2003). More recent research indicates work related road crashes account for 15% of the national road toll (Australian Transport Council, 2011) and 33% of work fatalities (Safe Work Australia, 2012). In regard to the cost of crashes, previous estimates indicate that nationally, costs are in the vicinity of $500 million per year while the total cost to the

Australian community of work related road crash is between $1 billion and $1.5 billion (Wheatley, 1997). More broadly, recent estimates within the National Road Safety Strategy 2011-2020 reveal that the annual cost of road crashes to the Australian economy is between $18 billion and $27 billion (Australian Transport Council, 2011). Given the costs, trauma and impact on society associated with work related crashes, it is necessary for organisations and road safety stakeholders to adopt improved risk mitigation processes and strategies to address this issue. An initial step in this process is to accurately identify drivers that are potentially more at risk of having a crash while driving for work.

Consequently, there would be value in developing a work driving risk assessment measure capable of identifying high risk drivers within an Australian work setting, as the efficacy of existing tools remains unclear, particularly within the Australian fleet environment. This doctoral thesis documents a program of research undertaken for the purpose of developing such an instrument.

1.2 DEFINITION OF WORK RELATED ROAD SAFETY

Historically, there has been use of various terms associated with work related driving and safety, and a scan of the literature identifies terms such as fleet safety, occupational driving safety, organisational driving safety and work related road safety. Throughout this thesis these terms will be used interchangeably, although the term work related road safety will be the primary term used. For the purpose of this research, the term work related road safety (and any of the terms mentioned above), refer to the activities and processes associated with the driving of vehicles while performing work related activities including driving to and from work, and the manner in which these activities relate to road safety.

1.3 DEFINITION OF RISK MANAGEMENT

The process of risk management involves the identification, assessment and prioritisation of strategies, resources and activities to minimise, monitor and control the effects or probability and impact of unfortunate events (AS/NZ ISO 31000:2009). Within the literature, the terms risk management and safety management are utilised somewhat interchangeably depending on the industry or profession (Grote, 2012) however, within this thesis, the term risk management will be used. Although risk management within an organisational setting can incorporate risks obtained from

unfortunate events such as impacts from financial markets, natural disasters or attacks from adversaries, within this thesis, risk management pertains to safety associated with work related driving activities. Risk management is an essential element for the prevention of work vehicle incidents (Wishart, Rowland, Freeman, Davey, 2011b). Within the organisational work driving context, risk management incorporates activities within an organisation such as measuring and evaluating driving safety risk, understanding the scope of the work related road safety issue, developing, implementing and actively promoting policies and procedures to ensure safe vehicle operations, monitoring driving safety progress and continuous refining of all of the above (ISO 39001:2012; AS/NZ ISO 31000:2009). In addition, risk management roles and responsibilities within the organisational driving context involve active management, to ensure that these roles and responsibilities are assigned and communicated throughout the organisation and any participation and responsibility is not viewed as just simply limited to the driver (ISO 39001:2012; AS/NZ ISO 31000:2009). A key point of importance is that risk management is dynamic, especially as situations and circumstances will be constantly changing, and consequently work driving risk management is a continuous process necessary to mitigate risk (AFMA, 2008b).

1.4 THE RATIONALE FOR THE RESEARCH

Research conducted within organisational fleet settings indicates that within many organisations, risk management practices are often undertaken with a specific focus on workplace processes that the organisation considers central to their core business, while not addressing risk management associated with driving for work in a similar capacity (Davey, Wishart, Rowland, Freeman & Banks, 2008; Wishart, Davey, & Rowland, 2004; Wishart & Davey, 2004). It has been previously suggested that the lack of risk management focus on work driving may be as a result of the asset management approach historically associated with fleet management in contrast to a safety management approach (Haworth, Greig, Wishart, 2008; Wishart & Davey, 2004). In other words, organisations primarily focus fleet management on the vehicle and consequently procurement and disposal, in contrast to a focus on the driver and safety behaviour. As a consequence, driving for work may not necessarily be perceived within organisational settings with similar levels of risk in contrast to these other workplace activities and their associated hazards. Furthermore, many

organisations, in managing the safety aspects associated with their vehicle fleet operations, do so in a reactive manner in contrast to a proactive approach, usually in response to negative events such as a fatality or expensive crash (Murray et al., 2003, Davey, Freeman, Wishart & Rowland, 2008). Additionally, many organisations use crash rates or insurance records post-crash to monitor and assess driver and organisational fleet safety performance (Wishart et al., 2011). Reliance on crash rates or insurance records as a primary measure of work driving safety can be problematic in regards to risk management. Risk management activities using crashes produces an over reliance on the management of risks after the event has taken place, which is contrary to attempting to prevent incidents from happening in the first instance. In order to improve work related road safety in the future, organisations need to progress toward a more proactive approach to driving safety risk management (Murray et al, 2003; Haworth et al, 2008; Wishart et al, 2011). In addition, legal obligations detailed within the next chapter of this thesis indicate an obligation for organisations to manage work driving risk. Consequently, to not only improve work related road safety, but also to satisfy minimum legal requirements, there is a need for organisations to be able to proactively identify drivers more at risk prior to their involvement in a crash.

In attempting to better understand road user behaviour and progress toward implementing a proactive approach capable of identifying at risk drivers, researchers have been investigating underlying psychosocial factors and the relationship these factors have to crashes. As a result, a variety of self-report measurement tools have been developed and utilised including the Driver Behaviour Questionnaire (DBQ) (Reason, Manstead, Stradling, Baxter, & Campbell, 1990), Driving Skill Inventory (DSI) (Lajunen & Summala, 1997), Driver Anger Scale (Deffenbacher, Oetting & Lynch, 1994), the Driver Attitude Questionnaire (DAQ) (Parker, West, Stradling, & Manstead, 1995) and the Safety Climate Questionnaire (SCQ) (Glendon & Litherland, 2001). However, many of these instruments have been developed primarily for the general motoring population (e.g., DBQ & DAQ), and thus researchers have noted that gaps remain in current knowledge regarding the exact road safety risks experienced by work drivers and the relationship these risks have with crash involvement (Davey, Wishart, Freeman, & Watson, 2007). In addition, many of these instruments fail to directly assess underlying aspects of driver

behaviour and particularly factors associated with increased crash risk in the work driving setting. For instance, many of these instruments do not assess specific issues believed to increase the risk of work related driving behaviour such as fatigue, workload, and mobile phone use (Freeman, Davey & Wishart, 2007).

Consequently, there is a need for further research investigating the contemporary and underlying factors thought to negatively influence work related driving safety within the Australian context. In addition, more research is required to further expand the scope of self-report driving safety measures, and in particular, develop a contemporary self-report risk assessment measure capable of identifying drivers at a higher risk of crash involvement, particularly within a work related driving setting.

1.5 THEORETICAL FRAMEWORK FOR THE RESEARCH

This thesis adopts Stuckey, La Montagne and Sim's (2007) Occupational Light Vehicle Use Systems Model as the primary theoretical framework to inform various stages of the research program. However, it should be noted that this research program was not designed to prove or assess any particular theory, but rather, utilise theory as a framework to aid in the development of a work driving risk assessment measure applicable to Australian fleet settings. Stuckey and colleagues' (2007) Occupational Light Vehicle Use Systems Model particularly highlights the complexities associated with driving within an organisational setting by incorporating not only the driver, but other multiple levels of influence on outcomes of crashes, injuries and fatalities. The model identifies various factors which influence drivers within the immediate and external environments such as vehicles and roads, patterns of work arrangements, the purpose and function of vehicles, along with the social, legal and economic policies governing work driving activities. Therefore, this model acknowledges the systemic nature of the work related driving context and thus provides guidance in conceptualising self-report risk assessment measure items particularly applicable to work related driving settings.

1.6 OVERALL AIM AND OBJECTIVES OF THE THESIS

Previous research within the general road safety arena has identified a wide range of factors contributing to the enormous burden of road crash and trauma within the road user community (Australian Transport Council, 2011; Husband, 2011;

World Health Organization, 2013). As a consequence, many of these factors have become the cornerstone of road safety campaigns and initiatives implemented by road and transport authorities, for example speed, fatigue, drink driving, and seatbelt use. It should also be noted that a fifth risk factor, driver distraction, has been attracting considerable attention within the road safety community. (Eg. Queensland Police Service, 2013). Within the work driving context, numerous potential influences on driving behaviour and crashes have been conceptualised, including issues associated with drivers and passengers, vehicle, road environment, work arrangements and policy and legislation (Stuckey et al, 2007). Researchers, in attempting to better understand driving behaviour have also developed a variety of measurement tools designed to establish and identify high risk driving behaviour, along with attitudes and motivations for the general driving population (Ozkan, Lajunen, Chiloutakis, Parker & Summala, 2006; Parker, et al., 1995; Lawton, Parker, Stradling, & Manstead, 1997). However, many of these measures have not proven reliable at predicting crashes despite their widespread continued use (Davey, et al., 2007; Dorn, Stephen, af Wåhlberg, & Gandolfi, 2010; af Wåhlberg , Dorn, & Kline, 2011). In addition, despite research showing that drivers driving for work are at a greater risk of involvement in a crash (Australian Transport Council, 2011; Newnam, Watson, & Murray, 2002; Sullman, Meadows, & Pajo, 2002) and are exposed to different risk factors (Stradling, Meadows, & Beatty, 2000), little research has been undertaken to develop work driving risk assessment measures within Australian organisational settings (Davey, Freeman & Wishart, 2006).

As a consequence, organisations often remain reactive in their work related road safety management and have become over reliant on determining “at risk” sectors of their vehicle fleet by utilising post-crash incident or insurance crash claim records (Haworth et al, 2008). Consequently, many organisations are not undertaking proactive risk management processes to determine the hazardous circumstances associated with the operational requirements of their vehicle fleet, along with the level and severity of risk related to employees driving for work, prior to the event they are trying to prevent actually occurs.

Accordingly, there are identified gaps in current work related road safety research. Firstly, there is a need to develop better risk management strategies and tools for organisational use in relation to work driving (Mitchell, Friswell, &

Mooren, 2012). Secondly, there is a need to better establish and understand the various factors that may influence aberrant work related driving within the Australian context (Newnam & Watson, 2011). Thirdly, in order for organisations to better proactively manage work related driving risk within Australian settings, there is a need for a reliable risk assessment measure to facilitate improvements in proactive risk management processes within the organisational vehicle fleet context (Wishart, Davey, Freeman & Rowland, 2007).

Therefore within this proactive approach and in order to address these identified gaps, this research program has an overall aim of: ***Contributing to the safety of work related drivers by developing and testing a new driver risk measurement tool for use by organisations.***

In addition, to achieve this aim, a number of key objectives underpin this program of research including to:

1. Investigate the ability of previously designed self-report measurement tools to predict work related driving risk within Australian vehicle fleet settings;
2. Investigate drivers' perceptions regarding what influences their driving behaviour within the organisational driving context;
3. Identify current and emerging issues that impact upon the development of self-report driving risk assessment measures within the work driving setting; and
4. Investigate the ability of a newly devised work driving risk assessment measure to predict crashes and offences within the light vehicle fleet context.

1.7 DEMARCATION OF SCOPE

This research program utilises samples of work drivers within the Australian work driving context and explores some of the unique aspects inherent within the Australian organisational fleet environment. Consequently, although this research program contains an "Australian flavour" with one objective specifically directed at the Australian fleet setting, due to similarities of work driving practices and risk assessment processes inherent in light vehicle fleets it is anticipated that any results

obtained throughout the research program will have international applicability and relevance.

The focus of work related road safety referred to in this thesis relates primarily to the light vehicle fleet. The light vehicle fleet is considered to be the operation of road registrable cars such as sedans, station wagons, people movers and vans, utilities and tray backs, along with four wheel drives and sport utility vehicles or SUV's. Although heavy vehicles often operating within a fleet context are also involved in work related crashes, the heavy vehicle (generally over 4.5 tonnes) sector within Australia is governed by specific heavy vehicle legislation and conditions. In addition, safety associated with the heavy vehicle sector comes with its own particularly unique set of issues and to amalgamate both the heavy vehicle and light fleet sectors into one research project would result in doing a disservice to both and is beyond the scope of this thesis. Therefore, this research focuses on work related road safety as it relates to light vehicle fleets. It should also be noted that for the purposes of this research, light vehicle fleet refers to road-registered vehicles but excludes equipment and machinery such as bobcats and lawn mowers, despite this equipment being capable of being registered. While it is acknowledged that there are risks associated with these types of vehicles, they are not included in this program of research, as bobcats and lawnmowers operate primarily within off road environmental settings and are generally road registered simply for ease and convenience of transportation between work sites.

Driving for work in this research includes not only driving within an organisational context within working hours but also includes drivers commuting to and from work. This is included for two main reasons. Firstly, many drivers of work vehicles are permitted to home garage these vehicles and will drive straight to a worksite other than their primary work environment as part of their work. Secondly within some states of Australia, for example Queensland, commuting to and from work is considered driving for work purposes and thus incorporated within workers compensation legislation (Workplace Health and Safety Queensland, 2013).

1.8 THESIS BY PUBLICATION

Consistent with the Queensland University of Technology Manual of Policies and Procedures (2010), this doctoral thesis and the program of research contained

within it have been undertaken through the presentation of published papers. According to this document:

> *"The Queensland University of Technology in Australia permit the presentation of theses for the degree of Doctor of Philosophy in the format of published and or submitted papers, where such papers have been published, accepted or submitted during the period of candidature; and where the quality of such papers is appropriate to PhD level research."*

Furthermore, published papers are defined as journal articles, book chapters, conference papers, and other forms of written scholarly works that are subject to a peer review process in a similar manner to papers published in a refereed journal. Published papers included within a PhD by publication must also be closely related in terms of subject matter along with forming a cohesive research narrative. Theses by publication are also subject to examination utilising the same standards as other traditional theses.

In relation to the format of a doctoral thesis by publication, according to the Manual of Policies and Procedures a thesis may be comprised of published papers, manuscripts accepted for publication, and manuscripts submitted for publication or manuscripts under review. The thesis must also comprise a minimum of three papers or manuscripts, although a larger number of papers or manuscripts are permitted if this is required to meet the expectations and the scope of the research and quality of research expected at a PhD level. At least one paper must have been published, accepted or be undergoing revision as a result of peer review feedback. In the case of papers having multiple authors, the PhD candidate must be principal author on at least two of the papers and also must obtain and include written permission from all other authors on the papers acknowledging that they may be used as a component of the thesis by publication being submitted. Finally, in papers where there are multiple authors, each paper must begin with a clear statement that details the contribution by each author to the research and publication. This thesis document and the program of research within it comply with these policies and procedures.

1.9 OUTLINE OF THESIS

This doctoral dissertation is undertaken by publication and therefore the structure of the thesis reflects the published papers that form the program of research.

The research incorporates five published papers, with each publication presented as a separate chapter (refer Table 1.1). The structure of this thesis is outlined below.

Chapter two presents a literature review of the research literature within the occupational safety domain demonstrating the magnitude of the work related road safety problem, particularly within Australia. The purpose of this chapter is to provide an in depth discussion of the overall work related road safety problem and outline the specific issues that are relevant to this overall thesis. This chapter will also discuss concepts associated with risk management and Australian legislative frameworks that clearly establish organisational obligations associated with mitigating risk associated with driving for work. The types of crashes occurring within the work related driving context will also be discussed highlighting some distinct differences between work related crashes and crashes within the general road user community.

The Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) will also be introduced. This model which conceptualises various potential determinants of injury and crashes was conceived to be specifically relevant to the work driving light vehicle fleet setting and is used to help guide the research program. In addition, this model will also be utilised within this chapter as a framework outlining the relevant research and literature regarding factors of potential influence to work driving behaviour and risk management. Consequently, various factors identified by previous research that impact on work driver behaviour will be discussed and examined for inclusion within the development of a work driving risk assessment measure.

Chapter three provides an overview of what a work driving risk assessment measure should look like. This chapter outlines relevant literature regarding the difficulties associated with predicting human behaviour along with discussing how this issue has been addressed in clinical, forensic and legal settings. This chapter then discusses a number of practical and research considerations associated with the development and use of a work driving risk assessment measure. The chapter concludes with revisiting the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) and an outline of the manner in which the model assisted in guiding the research program.

Chapter four provides an overview of the general structure of the publications incorporated within this thesis, presented as separate chapters five through to nine. This chapter will reiterate the aim and objectives of the research outlined in this thesis. Each manuscript will be summarised and an explanation will be given outlining how each manuscript fits within the research program and aligns with the research aim and objectives. This chapter will also outline a number of methodological issues particularly relevant to the operationalization of the program of research in this thesis.

Chapter six through to nine will present the publications as published. However, it should be noted that the references relating to each of these publications are included in the final reference list after chapter eleven in accordance with thesis by publication guidelines rather than within each publication and chapter.

Chapter ten contains the discussion and synthesises the findings obtained from each publication in relation to the specific research questions. Practical implications associated with the outcomes of the research in this thesis will be discussed along with an overview of the strengths and limitations of this research. A number of suggestions will also be detailed for directions in future research.

Table 1.1 Publications Included Within the Research Program

Paper One	Freeman, JE., Davey, JD., Wishart, DE. (2008). Predicting high risk behaviours in a fleet setting: Implications and difficulties utilising behaviour measurement tools. In L. Dorn, (Ed.), *Driver behaviour and training, Volume III* (pp. 175-187). England: Ashgate.
Paper Two	Freeman, JE., Davey, JD., Wishart, DE. (2008). A study of contemporary modifications to the Manchester Driver Behaviour Questionnaire for organisational fleet settings. In L. Dorn, (Ed.), *Driver behaviour and training, Volume III* (pp. 201-214). England: Ashgate.
Paper Three	Wishart, D.E., Davey, J.D., Freeman, J.E., Rowland, B.D. (2009). Identifying influences of driving behaviour: Could the Australian work related driving setting be unique? *Proceedings of the 5th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Big Sky, Montana, June 22-25.*
Paper Four	Freeman, J.E., Wishart, D.E., Davey, J.D., Rowland, B.D. (2010). Developing Risk Assessment Tools for Fleet Settings: Where to From Here? In Dorn, Lisa (Ed.) *Driver Behaviour and Training, Vol.IV.* (pp. 241-256). England: Ashgate.
Paper Five	Wishart, D.E., Freeman, J.E., Davey, J.D., Wilson, A., Rowland, BD. (2012). When Non-Significance Maybe Significant: Lessons Learned from a Study into the Development, Implementation and Evaluation of a Risk Assessment Tool for Fleet Settings. In Dorn, L. (Ed.) *Driver Behaviour and Training Volume V* (pp.197-214). England: Ashgate.

1.10 CHAPTER SUMMARY

This chapter has highlighted the over representation of work related road trauma and associated high level of risk involving work related driving particularly within the Australian context. It was argued that an important step in addressing this issue within the Australian fleet environment is the development of better risk assessment measures that can be utilised to proactively identify risky drivers and thus

inform the implementation of mitigation strategies prior to drivers being involved in a crash. This chapter has also provided an outline of the interchangeable terms often utilised in the road safety and work driving domains to describe work related road safety. A demarcation of the scope of this research program has been provided, highlighting that this research focuses on light vehicle fleets consisting of road registrable vehicles as opposed to including heavy vehicle fleets which are governed by a distinctly different legislation within Australia. A brief overview of the theoretical framework utilised in this thesis was also provided along with an outline of the requirements of submitting a thesis by publication. Finally, this introductory chapter has provided the reader with an outline of the chapters incorporated into this doctoral dissertation.

Chapter 2: Work Related Driving and Risk Factors

2.1 INTRODUCTORY COMMENTS

The overall aim of this chapter is to provide a detailed overview of the research literature relating to the work driving domain and associated risk factors in order to define the context of work related road safety and its uniqueness within the road safety domain. This review will utilise the Occupational Light Vehicle Use Model proposed by Stuckey et al. (2007) to provide a framework for reviewing the research literature which highlights various risk factors associated with driving within the work context. In addition, gaps in the research associated with risk management processes within the organisational context will be identified which will provide a rationale for establishing requirements for more proactive risk management procedures and tools for the identification of work drivers with increased crash risk.

2.2 THE SCALE OF THE ROAD TRAUMA ISSUE

Since the introduction of the combustion engine and the subsequent production of the first publicly available automobiles, global society has embraced the use of the motor vehicle. As a result, the motor vehicle has become a necessity in many countries for the transport of goods and people with vast contributions to increased levels of efficiency and support to economic and social development (World Health Organization, 2004). Unfortunately, since the first recorded road traffic fatality in 1896, worldwide road crashes continue to be a leading contributor to injury and death in society. Globally, approximately 1.24 million people die and as many as 50 million people sustain non-fatal injuries each year due to road crashes (World Health Organization, 2013). To obtain some perspective on the significance of the problem, this injury rate is more than twice the total amount of the Australian population which is currently just over 23 million people (Australian Bureau of Statistics, 2012). Previous research estimates the direct economic cost of road crashes around the world is approximately $518 billion US (World Health Organization, 2004), while recent research indicates that road traffic crashes cost low and middle income countries in excess of $100 billion US per year which equates to between 1-2% of

their gross national product (World Health Organization, 2013). Furthermore globally, fatalities from road traffic injuries are estimated to be the eighth leading cause of death, but if not addressed, are estimated to continue to rise to potentially become the 3rd leading causes of death behind heart disease and depression (World Health Organization, 2013; World Health Organization, 2004).

Within Australia, since 1925 when record keeping first commenced, there have been in excess of 180 000 fatalities on Australian roads (Department of Infrastructure and Transport, 2013). To illustrate the magnitude of this Australian road fatality figure, it can be compared to the loss of life through Australia's participation and involvement in wartime activities. According to the Federal Office of Road Safety (1998), the proportion of road fatalities in Australia since records have been kept (180, 000) greatly surpasses the total number of 89, 850 Australians killed in all four major wars consisting of World Wars I and II, Korea and Vietnam. Financially, it is estimated that road trauma costs the Australian economy approximately $27 billion annually (Department of Infrastructure and Transport, 2013). A further concern along with road fatalities is the alarming number of people injured each year due to road crash. For instance, research indicates that approximately 30, 000 people in Australia are hospitalised annually as a result of motor vehicle trauma (Risbey, Cregan & De Silva, 2010). Taken together, driving and vehicle travel is potentially one of the riskiest activities that many people perform on a daily basis. Furthermore, many people drive not only on a daily basis in their private life, but also often undertake work related driving as a component of their work. Therefore, given that many people are likely to drive for work, a proportion of the road safety trauma outlined above can be attributed to the work related road safety context.

2.3 PREVALENCE OF WORK RELATED DRIVING, INJURY AND CRASHES

The number of registered vehicles within Australia has demonstrated strong growth from 13.9 million vehicles recorded as registered in 2005 to a total of 16.1 million in 2010 (Australian Bureau of Statistics, 2010). In addition, the largest growth sector in regard to type of vehicle, excluding motor cycles, has been light commercial vans. Furthermore, if vehicle sales are any indication, the majority of vehicles driven on Australian roads are used for work related driving, given that by far the majority of vehicles purchased and registered in Australia are purchased for

inclusion within a company vehicle fleet (AFMA, 2008). The high level of motor vehicle use in regard to the population commuting to and from work that can be viewed on traditional work days around urban areas during designated "peak traffic times", is further testament to the use of motor vehicles in regard to work purposes. Therefore, it can be seen that the motor vehicle has not only become a central component of our transportation requirements, but also is utilised as a key element in our working life. Consequently, work related driving and the aspects of safety associated with this activity are areas gaining increased attention by road safety practitioners, advocates, researchers, and industry.

In regards to safety associated with driving for work, as noted in section 1.1, research has demonstrated that work related drivers on average report a higher level of crash involvement compared to personal car drivers (Australian Transport Council, 2011; Downs et al., 1999; Lynn & Lockwood, 1998). Previous research has also indicated that road crashes are the most common form of work related fatalities (Haworth et al., 2000). Work related road crash injuries have been shown to be twice as likely to result in death or permanent disability as other workplace injuries (Wheatley, 1997) and the average time lost due to injury is greater than any other workplace claim (Stewart-Bogle, 1999). Research has also found that work related road fatalities account for up to 23% of work related fatalities in Australia and 13% of the national road toll (Murray, et al., 2003), while more recent research indicates work related road crashes account for 15% of the national road toll (Australian Transport Council, 2011) and 33% of work fatalities (Safe Work Australia, 2012).

Safe Work Australia (2012) provides some further insight into the magnitude of the work related road safety issue. Analysis of data that is obtained from workers compensation claims, notifications under occupational health and safety legislation and coronial data, indicate that in the financial year 2010-2011 a total of 374 work related traumatic injury fatalities occurred in Australia. Of these 374 fatalities, 220 resulted from injuries sustained while working, a further 110 fatalities occurred while travelling to or from work, and a further 44 died as a result of being a bystander to another person's work activity. To obtain insight into the magnitude of the work related road safety issue, the data indicates that from the total (374) of all work related traumatic injury fatalities, half (183) of the fatalities were as a result of a road crash on a public road.

In relation to workers compensation fatality claims alone, according to Safe Work Australia, (2012b) in the period 2009-2010 preliminary data indicates there were 194 compensated fatalities in Australia, with vehicle crashes representing the most common mechanism of injury accounting for almost one third (57 deaths) of all fatality claims. Furthermore, vehicle crashes represent twice as many compensated fatalities as the second most common mechanism of injury which is long term exposure to chemicals and substance. It should also be noted that vehicle crashes have remained the highest mechanism of injury for workers compensation fatality claims for the last decade (Australian Safety and Compensation Council, 2006; Safe Work Australia, 2009; 2010; 2012).

The over representation of work vehicle crashes in road fatalities along with workers compensation fatality claims, suggest that the prevalence of crashes and injury associated with driving for work is an immense issue requiring attention in road safety. It also provides an indication that within a work environment, better risk management practices and intervention strategies are required. One crucial aspect of risk management is the need to proactively identify not only the risks associated with work practices (such as driving) but also to identify drivers who are at a higher risk of being involved in a dangerous vehicle incident (such as a crash) in order to implement risk mitigation processes. To assist in better understanding the work driving context and crash risk the following section outlines relevant research relating to the types of crashes that predominantly occur within work driving settings.

2.4 TYPES OF CRASHES THAT OCCUR WITHIN THE WORK DRIVING CONTEXT

Vehicles driven for work purposes obviously operate within the general road user environment and thus, are reflected in the typical road user activities and crashes that occur within the general road user setting. However, while there are some similarities between the types of vehicle crashes involving fleet and non-fleet vehicles, there are also some distinct differences in fleet crashes which may inform and influence the management of risks associated with work related driving. For example, research conducted by Symmons and Haworth (2005) using crash data from New South Wales for the period 1996-2000 where vehicle crashes could be identified as fleet and non-fleet vehicle crashes, demonstrated that fleet vehicles had

a higher rate of crash involvement per 10, 000 registered vehicles and drivers were less likely to wear seatbelts. The results of this study also indicated that fleet vehicle crashes were more likely to result in a fatality but less likely to result in an injury in comparison to non-fleet vehicles, while non-fleet crashed vehicles were more likely to involve two or more injured people.

In other research, Broughton, Baughan, Pearce, Smith and Buckle (2003) found that even after controlling for age, gender, distance travelled, and motorway driving, car drivers driving for work had a higher risk of injury crashes than other drivers. In Queensland, a study conducted by Newnam, Watson and Murray (2002) using self-report data also found higher crash rates among drivers driving for work in comparison to driving in their private vehicles with a crash rate of 0.07 crashes per 1000 kilometres in work vehicles in comparison to 0.06 crashes per 1000 kilometres in private vehicles. Although people driving for work purposes may drive longer distances and spend a large proportion of their work day driving, exposure is not the only factor contributing to crashes. Broughton et al., (2003) suggests that people driving for work purposes may be more likely to use mobile phones, be more likely to eat while driving, be distracted by work related issues and be more likely to be travelling at excessive speeds to arrive at appointments in comparison to other general road use drivers.

In regard to crashes and the type of road user movement being undertaken at the time of the incident, analyses of data by Symmons and Haworth (2003) indicated that the most common type of crash in both fleet and non-fleet vehicles was rear end collisions, although fleet vehicle rear end crashes were more common in comparison to non-fleet vehicles. Other research undertaken utilising incident data over a 12 month period involving a vehicle fleet located in Queensland, demonstrated that the most common type of incident involved vehicles manoeuvring and parking, followed by rear end type incidents and hitting stationary objects (Wishart et al., 2004). Further analyses of this data indicated that the majority of the parking manoeuvring type incidents occurred within one particular car parking facility and the authors suggest that there may be other factors contributing to the crashes such as obstructed vision while reversing, work schedules, rushing and distractions such as equipment, pedestrians and signage. Previous research conducted across a variety of fleet

settings within the Australian context by Wishart, Davey and Freeman (2007), indicated that the most common types of crashes involving fleet vehicles are:

- Reversing
- Rear Enders
- Road Conditions
- Loss of Control
- Animal Related Incidents
- Damage Whilst Parked
- Accumulated Damage

Recent research across a number of local government fleets within Queensland also provided similar results indicating that the most common types of crashes are still associated with reversing, damage whilst parked, rear end crashes and accumulated damage (Wishart, Rowland & Davey, 2010).

Further insight into particular aspects of fleet crashes can also be obtained through data obtained via organisational motor fleet benchmarks. Benchmarking within a fleet environment often consists of undertaking an activity of conducting comparisons of crash data and organisational fleet management processes across similar organisations and vehicle fleets. For example, a strong indicator in relation to safety performance within a fleet can be ascertained by the proportion of driver "at fault" claims and subsequent comparisons across organisations. Driver "at fault" claims are the proportion of total crashes that have occurred within a vehicle fleet over a determined period of time whereby the insurance provider or crash investigation team has determined which vehicle or road user was primarily responsible for the crash occurrence. Within benchmarking processes, crashes are determined to be either "at fault", "third party at fault" or some proportion of "equal contribution of fault" in relation to the responsibility for the crash occurrence. Within a vehicle fleet, the proportion of "at fault" claims are a robust indicator of the proportion of an organisation's fleet crashes that were preventable. In other words, the responsibility for the crash occurring primarily rests with the organisation and the organisation's driver and not a third party, thus providing evidence that the crash was

primarily contributed to by the behaviour of the organisation's driver or some deficiency in organisational process.

Annual fleet benchmark indicators conducted by the Australasian Fleet Management Association (AFMA) and Lumley Insurance utilising various passenger and light commercial fleets operated throughout Australia demonstrated benchmarks of "at fault" claims for AFMA fleets averaged 65% of all fleet crash insurance claims while Lumley benchmarks of other fleet clients participating in benchmarks averaged 30% "at fault" claims (AFMA, 2009). In addition, annual benchmark results across a number of local government vehicle fleets over a three year period indicated that the minimum proportion of "at fault" crashes in one organisation was 42% of their total crash claims while the highest proportion for an organisation across this time was 73% of total crashes (Wishart, Rowland & Davey 2011).

Overall, the results obtained from across these various annual benchmark activities would suggest that a high proportion of crashes experienced within these organisations were primarily the responsibility of the organisation involved and the organisation's drivers, in contrast to other road users. Awareness of benchmark results such as these, provides compelling evidence of the need for organisations to address underlying issues contributing to fleet crashes, especially considering that many of the benchmark results demonstrate the primary responsibility for the incident in the first place was not somebody else's responsibility, but rather the fleet vehicle and driver. This evidence thus indicates that there is a need for organisations to implement thorough risk management procedures and implement safer work driving processes.

Although the above information provides evidence of the type of crashes involving vehicles within the work context, it offers only some suggestions regarding the underlying factors that may contribute to risky work driving behaviour and crashes. Given that work related driving operates within an organisational context, in order to obtain further insight into the underlying issues contributing to work related crash involvement, factors believed to be associated with risky driving behaviour within the work setting will require closer attention.

2.5 CONCEPTUALISATION OF FACTORS INFLUENCING WORK DRIVING BEHAVIOUR

Given that there are potentially numerous risk factors within the organisational vehicle fleet context that influence work driving behaviour, it is pertinent to provide some guiding framework around which to structure the review of relevant research literature and the subsequent program of research.

The Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) is a model that encapsulates an extensive range of potential determinants of crashes and injury within the work related driving setting. In addition, the model conceptualises these influences across a number of layers and includes a wide range of specific examples within each layer. More particularly, the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al (2007) was conceptualised specifically to be applicable to the light vehicle fleet setting in contrast to incorporating a heavy vehicle fleet, which is in line with the scope of this research program. Therefore the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) represents a useful framework around which to structure a review of the work related road safety research literature.

2.5.1 Occupational Light Vehicle Use Systems Model

The Occupational Light Vehicle Use Systems Model (refer Figure 2.1) is a model proposed by Stuckey, La Montagne, and Sim (2007) as a means of better understanding the complexities associated with various influences on work related driving, safety and occupational health and safety. The model proposes multiple levels of influence relating to work driving safety particularly in regards to outcomes such as crashes, injuries and fatalities.

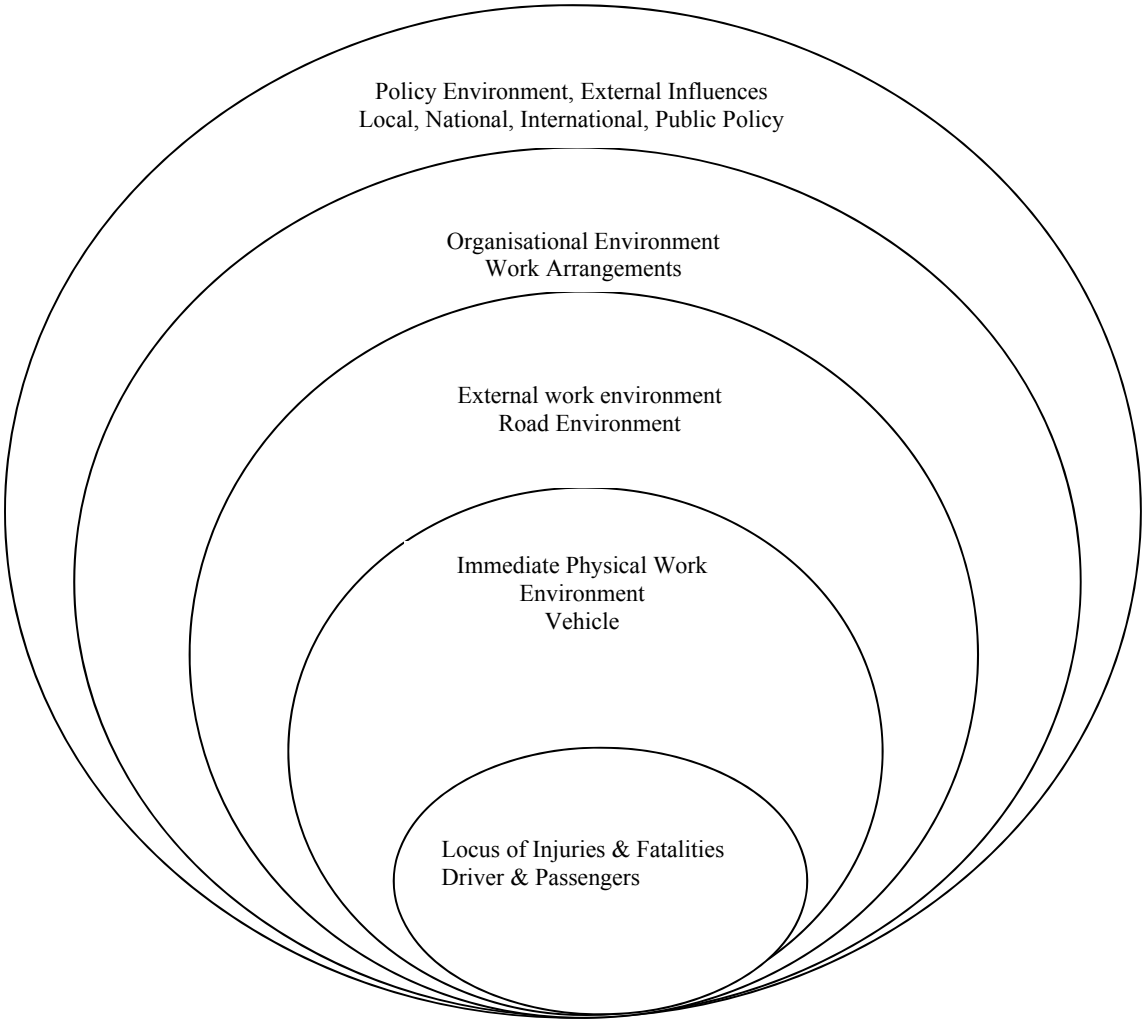

Figure 2.1: Occupational Light Vehicle Use Systems Model

The Occupational Light Vehicle Use Systems Model appears to have been conceptually informed by socioecological models such as Bronfenbrenners' Ecological Framework for Human Development (1999). Bronfenbrenner's model proposes that in order to understand human development in regard to influences on behaviour and attitudes, the ecological system in which growth occurs needs to be taken into account (Bronfenbrenner, 1999). In other words, in order to better understand human behaviour, the context and influences of factors within various levels of the environment need to be considered. Similar to the Occupational Light Vehicle Use Systems Model, Bronfenbrenners' Ecological Framework for Human Development (1999) also outlines five layers, with the individual as the central unit

and each layer encompassed by the next layer. Each of these layers is termed: individual referring to the individual as the central unit; microsystem relating to family, peers, colleagues; mesosystem which is a connecting layer to transverse beyond a dyad; exosystem which defines the larger social system and includes social entities such as neighbourhood, organisation and industry; and macrosystem which incorporates an even wider spectrum of a social system such as cultural values, customs and laws (Bronfenbrenner, 1999).

Although Bronfenbrenner's model has primarily been applied to understanding human development, in recent times it has been utilised as a framework for the development of research and competence models for safety specialists (Bertaitis, Briede & Peks, 2012), adolescent motor vehicle safety (Runyan & Yonas, 2008), analysing and modelling community resilience to natural disasters (Boon, Cottrell, King, Stevenson, & Millar, 2012) and research and development of an instrument to measure parent and caregiver child passenger safety (Dupont Knobloch, 2007). Collectively, this research has shown that Bronfenbenner's (1999) model provides a suitable framework to assist in conceptualising not only the vast range of contextual factors influencing an individual but also consideration of the interactions between the individual and factors of influence.

The Occupational Light Vehicle Use Systems Model provides a conceptual framework in a similar manner to that offered by Bronfenbrenner (1999). More particularly, it is highly relevant to the current program of research by specifically focussing on the factors that influence work driving in the light vehicle fleet context. According to Stuckey et al., (2007), one of the limitations with other theoretical models applicable to general road safety, is that they have generally focussed on driver behaviour which is often viewed in isolation, rather than as driver interactions with other aspects and circumstances of the road environment and the work setting. In addition, the authors' argue that road safety associated with work and transport is particularly complex due to the cross over between workplace health and safety and transportation and road safety.

Stuckey and colleagues (2007) suggest that traditional occupational health and safety approaches alone do not incorporate processes to encapsulate the various social, political, cultural and economic influences that are relevant and applicable within a work related road safety setting involving light vehicle fleets. In contrast,

the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) acknowledges the vehicle as the workplace and that a driver's activities are functioning within a workplace encompassing varied work arrangements many of which are undertaken within a road transport system. In addition, the model acknowledges the complexities within a workplace associated with occupational health and safety and road factors. Furthermore, the model concedes that the nature of the workplace is distinctly different from other settings in that the work environment is external to a traditional workplace and primarily outside the direct control of the employer. Consequently, this model recognises the flexibility associated with current occupational driving activities and the potential influences on aspects of work related road safety, particularly those associated with risky driving as reflected in crashes, injury and fatalities.

The Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) consists of five levels with each level consisting of a range of potential determinants of crashes, injury and fatalities. As shown in Table 2.1, the five levels consist of : (i) locus of injury which relates to factors associated with drivers and passengers such as age, gender, driving exposure, and behaviours; (ii) immediate physical work environment which relates to the vehicle factors, such as ownership, maintenance etc; (iii) external work environment which consists of the road environment and factors such as design, other road users, road conditions; (iv) organisational environment characterised by typical work arrangements such as flexible hours, shift patterns; and (v) policy environment incorporating various aspects such as legislation and public policy.

The following section will review the available research relating to potential determinants of work related crashes and injuries conceptualised within each of the five levels of the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007).

Table 2.1: Potential determinants of occupational light vehicle use injury and crashes

Model level		Potential determinants
Locus of injury	Driver & passengers	Age, gender driving experience, number of users Driving exposures –frequency, kilometres, hours, patterns, times of driving, day/night, trip length occupation, industry, number of jobs, driving purpose, number of vehicles, income, work equipment. Driving behaviours - drug/alcohol consumption driving demands, work fitness sleep patterns
Physical work environments immediate and external	Vehicle	Ownership, purpose, usage, age type, model engine capacity, fuel type mass, weight size occupant capacity, maintenance, condition, odometer reading, colour, load capacity, road worthiness crash worthiness
	Road environment	Design- single, multiple lanes, divided freeways, intersected, rural, urban, suburban, local, state, national Other road users- traffic pedestrians, animals, congestion, population density Road design elements- surface, condition, geography topography, lighting, curves Weather conditions
Organisational environment	Work arrangements	Work patterns - management structures, production requirements, control, autonomy Work arrangements - traditional work, contingent work, outsourcing, sub-contracting Work design - shift work, safety policies, training, systems management and monitoring, driving activities, scheduling, work demands, and pressures, in vehicle communication systems, work equipment Vehicle ownership maintenance arrangements, turnover, management systems, Incident recording data management systems External business demands and expectations
Policy environment External influences local national and international	Public policy	Road safety legislation Work safety legislation Vehicle roadworthiness standards and implementation processes Driving behaviour related legislation phone use seat belt use violation management OLV population surveillance crash injury fatality data classification collection Registration and insurance management OLV OHS enforcement systems Terminology - local national international

2.6 POTENTIAL DETERMINANTS OF WORK-RELATED CRASHES AND INJURY ASSOCIATED WITH DRIVERS AND PASSENGERS

As depicted in Table 2.1, the first level associated with drivers and passengers incorporates potential determinants of crashes and injuries such as age, gender, driving exposure and driving behaviours for example speeding and alcohol consumption. A large body of research has identified that a number of these factors are associated with risky driving behaviour and crash involvement in both work and non-work drivers. The following sections outline research evidence relating to several of the potential determinants (factors) as outlined within Stuckey et al.'s (2007) Occupational Light Vehicle Use Systems Model.

2.6.1 Age and Gender

Previous research has consistently highlighted that the risk of being involved in a crash is much higher for drivers less than 25 years of age in comparison to any other age group of drivers (Guo, Simons-Morton, Klauer, Ouimet, Dingus & Lee, 2013). In addition, young drivers appear to be particularly vulnerable in the period immediately after obtaining a driver's licence (Bates, 2012), and this elevated risk has been consistently demonstrated over the past three decades (Elvik, 2010). Although the frequency of crash involvement in young drivers declines with experience, crashes involving young adults still remains substantially higher than that of drivers over the age of 25 years (Guo et al, 2013). Although research has demonstrated increased crash risk relative to young drivers, researchers have also indicated that a number of other factors relative to age may also cumulatively enhance such risk. For example, young drivers being new to driving have a lack of driving experience and are known to engage in riskier driving activities as well as be influenced by social influences and peer group pressure (Sarma, Carey, Kerrvick, & Bimpeh, 2012).

In addition to age, research has highlighted gender differences in regard to crash involvement with males being over represented in worldwide crash statistics in comparison to females (Tsai, Anderson, & Vaca, 2008). In regards to the differences in crash involvement between males and females, research has indicated that males may be more prone to involvement in risky driving associated with higher levels of sensation seeking and impulsivity (Boyce & Geller, 2002).

However, it is unclear whether these same patterns are similarly represented across fleet settings, or if different population demographics reduces this risk. For example, many fleet operations (while comprising some young drivers) predominantly consist of drivers in older age categories. This is evidenced by samples in recent research demonstrating average ages in the early to mid-forty years (Mitchell, et al., 2012; Newnam & Von Schuckmann, 2012; Oz, Ozkan, & Lajunen, 2010). However in contrast to age, many fleet research samples consist primarily of male drivers (Mitchell, et al., 2012; Oz, Ozkan, & Lajunen, 2010; Rowland Davey, Freeman & Wishart, 2010) and consequently this over representation of male drivers in vehicle fleets combined with what is known from research regarding male drivers and crash risk, could result in a potential increase in work related vehicle crash risk.

2.6.2 Driving exposure

Research indicates that drivers are more at risk of being involved in a crash simply through exposure to the driving environment (Jun, 2006). In other words, drivers spending more time on the road have a higher probability of experiencing crash involvement in contrast to drivers that spend less time on the road. However, exposure to increased driving risk can be conceptualised in a variety of ways including the time people spend driving (Santamarina-Rubio, Perez, Olabarria, & Novoa, 2014), the frequency and regularity of driving, kilometres travelled, and driving patterns consistent with potential determinants outlined in the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) or to previous crash locations or black spots (Jun, 2006).

Previous research within a work driving setting has also indicated that drivers spending more time on the road are also at a greater risk of incurring traffic infringements (Davey et al., 2006). These results could be viewed as an indicator of sustained periods of risky driving behaviour and consequently increased potential for crash involvement. In regards to driving exposure, estimates suggest that in high income countries, for each 1% reduction in overall kilometres travelled in vehicles a corresponding 1.4-1.8% reduction in crashes may occur (Litman, 2000; Peden et al., 2004). Consequently, it would appear that there is compelling evidence that driving exposure is a potential influence to work driving crashes and thus worthy of further exploration.

2.6.3 Speeding

Although crashes may have multiple contributing factors, speeding is consistently identified as a leading contributor to serious crashes and fatalities. For example, within Europe, speeding has been identified as a contributor to approximately 30% of fatal crashes (European Road safety Observatory, 2013). Within Australia, speeding has also been identified as the main behavioural contributing factor to crashes for both fatalities and serious injuries, accounting for 34% and 13% respectively (Australian Transport Council, 2011). In addition, it should be noted that the probability of a person being seriously injured in a crash exponentially increases with vehicle speed (Fildes, Langford, Andrea, & Scully, 2005). Consequently, road safety initiatives aimed at reducing the incidence of speeding and the associated outcomes have become a road safety campaign priority within the Australian setting, with the anti-speeding message being one of the four pillars of the Safe System approach outlined in the national road safety strategy 2011-2020 (Australian Transport Council, 2011).

In regard to the work related driving setting, previous research conducted by Broughton et al., (2003) has suggested that fleet drivers may have a propensity to speed due to travelling further distances or spending more time driving, both of which increases exposure and opportunities for speeding to occur. In addition, Broughton et al., (2003) further suggest that fleet drivers have a propensity to engage in riskier driving as a result of a lack of care due to the vehicle not being their own.

Other research has identified in a sample of professional mini bus and taxis drivers that speeding increased in these drivers as they became more familiar with the road environment and consequently more comfortable with or desensitised to potential hazards encountered (Oz, Ozkan & Lajunen, 2009). In an Australian study utilising a sample of taxi drivers, speeding was considered by the participants an acceptable behaviour while driving for work (Rowland, Davey, Freeman & Wishart, 2009). However, the limited research findings on professional drivers' remains mixed. For example, research conducted by Symmons and Haworth (2005) investigating crashes involving fleet vehicles and non-fleet vehicles within New South Wales utilising crash data demonstrated that drivers of light commercial vehicles at the time of a crash were actually less likely to have been speeding in comparison to non-fleet drivers. Similarly, other Australian research utilising self-

reported driving behaviours in a sample of 204 work drivers, revealed that drivers within this sample were more likely to speed in their personal vehicle that while driving a work vehicle (Newnam, Watson & Murray, 2002).

In summary, while research provides compelling evidence demonstrating the impact of speed in crashes and injuries, within various fleet settings, results indicating work drivers propensity to speed have been somewhat mixed and warrant further investigation.

2.6.4 Alcohol and Drug related driving

Within the general road safety setting there is a plethora of evidence attesting to the over representation of alcohol and drugs as major contributors to fatalities and injuries. Across all jurisdictions in Australia, random breath testing (RBT) is utilised as the primary law enforcement tool to deter drink driving as well as apprehend offenders (Ferris et al., 2013). In addition, research has highlighted Australia as having the most successful RBT program in comparison to other countries in regards to crash reductions (Erke, Goldenbeld, & Vaa, 2009). Unfortunately, despite the prevalence and success associated with RBT initiatives, on Australian roads more than one in five driver and rider fatalities have been determined to have a blood alcohol concentration exceeding the legal limit (Australian Transport Council, 2011).

In regards to drug driving, it has been estimated that over a 10 year period within Australia, approximately one in four drivers killed in road crashes returned a positive drug test (Drummer et al., 2003). In Queensland since the introduction of random drug testing in 2007 and by the year ending of 2011, more than 71,000 drivers have been subjected to testing with results indicating a detection rate of 1 in 40 drivers (Queensland Police Service, 2013b). These disturbing results provide testament to the problem of alcohol and drug related driving on Australian roads.

In regards to work drivers, little research has been undertaken specifically investigating drink and or drug driving. However, it has been suggested that the prevalence of these activities among professional drivers is likely not dissimilar to the general road user population (Bjerre & Kostela, 2008). Research across a number of Australian fleet related organisations revealed that many organisations are implementing policies and practices that are often stricter than the legislation requires and are adopting a zero blood alcohol requirement on work drivers

(Haworth, Grieg & Wishart, 2008). In fact, the author of this thesis while undertaking work within the fleet domain recently has been subjected to drug and alcohol testing upon arrival at an organisation's work site in accordance with their drug and alcohol policy that includes not only employees but also contractors. In addition, drug and alcohol testing equipment is in plain view (at this work site) along with promotional material on safety notice boards indicating the impact of drugs and alcohol on not only work, but also driving safety.

Consequently, although drug and drink driving are major factors contributing to crashes, industry appears to be implementing initiatives aimed at limiting the impact of drugs and alcohol and improving work related road safety and workplace safety more generally.

2.6.5 Aggression

Researchers and road safety practitioners have expressed concern with regards to the increasing frequency of aggressive driving and incidents of road rage (Beirness, Simpson, Mayhew, & Pak, 2001; Hennessy & Weisenthal, 2005, Pepper, 2003; Parker Lajunen & Summala, 2002). Although there is some disagreement regarding the definition of aggressive driving, it is generally understood to be linked to an emotional state such as anger and the experience of feelings of frustration (Gonzalez-Iglesias, Gomez-Fraguela, & Luengo-Martin, 2012) which is often displayed while driving such as shouting abuse, physical gestures, direct threats, flashing on and off of headlights (Herrero- Fernandez, 2013; Gonzalez-Iglesias et al, 2012) and other risky driving behaviours such as speeding and tailgating (Deffenbacher, Filetti, Richards, Lynch & Oetting, 2003).

Previous research has found that anger and consequently aggressive driving is a prevalent factor in road crashes (Dahlen & Ragan, 2004). In addition, males tend to act more aggressively and express their anger in a more aggressive manner while driving on the road in comparison to females (Gonzalez-Iglesias et al, 2012). In research conducted within a work setting among different professional driver groups, aggressive drivers were found to have engaged in driving at higher speeds particularly on inner city roads, and were involved in more traffic crashes in comparison to non-aggressive drivers (Oz Ozkan and Lajunen, 2009). Consequently, aggressive driving appears to be an extremely relevant risk factor associated with

driving within not only the general road user setting but also in a work driving setting.

2.7 POTENTIAL DETERMINANTS OF WORK-RELATED CRASHES AND INJURY ASSOCIATED WITH IMMEDIATE PHYSICAL WORK ENVIRONMENT

The second level of potential determinants of crashes and injuries conceptualised by Stuckey and colleagues (2007) relates to the influences associated with the immediate physical work environment. In particular, within the occupational light vehicle use setting, the immediate physical environment is conceptualised as the vehicle (Refer Table 2.1). Typical influences mentioned in regards to the vehicle include ownership and purpose of use, maintenance and safety rating or crash worthiness.

2.7.1 Vehicle procurement

Within many organisations the selection and procurement of vehicles and the manner in which vehicles are maintained could also inadvertently influence safety aspects associated with work related driving. Research has indicated that adhering to best practice in fleet selection and fleet maintenance contributes to a lower incidence of breakdowns, decreased crash involvement caused by vehicle defects, and increased safety by choosing safer vehicles and accessories (Anderson & Plowman, 1999; WA, 2003). It is suggested that purchasing decisions be made in consultation with employees to determine the fleet/vehicle safety requirements and specifications where decisions may affect those employees (Anderson & Plowman, 1999). This process would not only satisfy legislative compliance (Health and Safety Act, 2011) but also be consistent with good risk management approaches to encourage accountability and ownership of risk (AS/NZ IOS31000, 2009). In addition, Anderson and Plowman (1999) recommend that goods and services purchased by the organisation (such as vehicles, safety equipment, and vehicle modifications) are checked for compliance with purchase order requirements and/or specifications as a form of feedback. Furthermore, vehicle selection should be based on the tasks and circumstances for which the vehicle will be used, for example, purchasing four wheel drive vehicles for off road applications or installing driving lights for night country driving to increase safety in particular environmental conditions (WA, 2003).

Employers under work health and safety legislation are required to provide a safe place to work and vehicles are legislated as a workplace (Work Health and Safety Act, 2011). Therefore, safety features within vehicles are required to be considered when selecting for work use, for example, daytime running lights, seatbelts, anti-lock brakes (ABS) and airbags, etc., (AFMA, 2008b; QFleet, 2010). In addition, the safety benefits of reduced trauma to occupants in a five star crash tested vehicle, in comparison to vehicles incorporating less safe features has been consistently demonstrated (ANCAP, 2012).

2.7.2 Vehicle maintenance and ownership

A further process for consideration in management of risks associated with the vehicle is vehicle maintenance. The organisation, although likely having ownership of the vehicle and subsequent overall responsibility for the maintenance of the vehicle, is not in a position to micro manage all activities associated with the maintenance. For instance, although an organisation may implement processes to ensure that scheduled maintenance is undertaken in accordance with legislation (Work Health and Safety Act, 2011) some responsibility rests with individual drivers to undertake periodical vehicle safety and maintenance checks such as tyre pressure and fluid level checks and notify the organisation's service department should the vehicle require extra maintenance outside normal scheduled servicing timeframes. Periodical maintenance checks undertaken by the employee as a risk mitigation process prior to use of the vehicle will ensure that the vehicle is compliant with necessary safety and road worthy requirements at the commencement of a journey (Wishart, Rowland & Davey, 2010).

In summary, the immediate physical work environment and in particular the vehicle, along with processes associated with the organisational context of the vehicle, such as vehicle selection and procurement along with pre start maintenance checks, are activities that contribute to the safety of vehicle users. Therefore activities and processes associated with the vehicle as the immediate work environment are considerations not only in risk management, but also risk assessment of work related road safety. Consequently, a proactive risk assessment measure assessing at risk drivers could consider incorporating items relevant to organisational and vehicle related influences such as procurement, maintenance and crash worthiness.

2.8 POTENTIAL DETERMINANTS OF WORK-RELATED CRASHES AND INJURY ASSOCIATED WITH THE EXTERNAL WORK ENVIRONMENT

As depicted in Table 2.1, Stuckey and colleagues (2007) have conceptualised a range of potential determinants of crashes and injury associated with the external work environment and in particular the road environment. According to the Australian Transport Council (2011) crashes at intersections, vehicles running off the road and head on crashes account for the majority of serious road casualties within the Australian road network. Consequently, safer roads are considered one of the "cornerstones" of the Australian National Road Safety Strategy utilising a safe system approach due to the influence that the road infrastructure has in preventing or minimising the consequences of these types of crashes (Australian Transport Council, 2011).

However, it should also be noted that many organisational vehicle fleets operate in remote regional locations and as a result are likely to experience many of the worst types of road conditions. Therefore, while the external environment is recognised and acknowledged as an integral component associated with the incidence and severity of crashes and injury, within the context of work driving improvements, this domain is largely outside of the control or scope of the organisational stakeholders operating vehicle fleets. Consequently, while evidence exists as to the impact of the road environment on work driving behaviour, conceptually and practically, interventions and safer driving behaviours may be better addressed within the organisational environment context and risk management processes outlined within the next level of the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007).

2.9 POTENTIAL DETERMINANTS OF WORK-RELATED CRASHES AND INJURY ASSOCIATED WITH THE ORGANISATIONAL ENVIRONMENT

As depicted in Table 2.1, the fourth level conceptualised as the organisational environment depicts a range of potential determinants to occupational light vehicle use crashes and injury including incident recording systems, management systems, work patterns and work design and arrangements. It is acknowledged that organisational vehicle fleets operate within the general road environment and as such are obligated to operate in accordance with general road rules and regulations. In

addition, organisations are also likely to obtain a range of safety benefits within their vehicle fleet as a direct result of road safety initiatives targeting general road users. Previous research has also recognised that driver behaviour can be influenced by various organisational characteristics, the roles employees play and the interplay between these aspects (Oz, Ozkan, Lajunen, 2013). Consequently, even though organisational fleets do operate within the general road community there are a number of unique organisational issues influencing driver behaviour that also require acknowledgement and consideration to improve driving safety within the organisational setting.

A recent review of work related driving safety and the development of an intervention framework conducted by Newnam & Watson (2011) provides some evidence attesting to the impact of the organisational environment on driver behaviour with a proposed intervention framework to improve work driving safety incorporating interventions at the organisational level, work group level and individual level. Other research within fleet settings have highlighted specific issues such as safety climate (Wills, Watson & Biggs, 2006); culture (Husband, 2011); time pressure and mobile phone use (Salaminen & Lahdeniemi 2002); crash and incident reporting and management (Wishart, Davey & Freeman, 2007); risk management (QFleet 2010); vehicle selection, procurement and vehicle maintenance (Mitchell, Friswell & Mooren, 2012); and fatigue (Haworth, et al 2000). Additionally, recent case study research highlights the necessity for organisations to include many of these organisational processes along with others within their general organisational work driving risk management approach (Wishart, Rowland & Davey, 2010; Wishart & Rowland, 2010).

Accordingly, a number of potential determinants of crashes and injury encapsulated within the occupational environment will now be individually discussed outlining the relevant research and implications associated with each aspect in consideration of this thesis.

2.9.1 Risk management

Processes associated with risk management practices relating to vehicle use can have a large influence on work related road safety and an employee's perceptions of the risks associated with driving (Kolman, 2010; Wishart, Rowland & Davey, 2010). Research conducted within organisational fleet settings indicates that many risk

management practices are often undertaken with a specific focus on workplace processes that the organisation considers central to their core business, while not addressing driving for work processes with similar levels of consideration (Haworth et al, 2008, Davey et al., 2008; Stuckey et al, 2007; Wishart et al., 2004; Wishart & Davey, 2004). As a consequence, driving for work may not necessarily be perceived with similar levels of risk in comparison to these other workplace activities. For instance within the occupational safety context, a priority within many organisations is to primarily focus on hazards and risks that management and employees consider central work processes. For example, within the mining or high voltage electricity network, risk management processes relating to mining or high voltage activities are underpinned by a framework of zero harm (Wishart, Davey, Rowland, & Banks, 2009). Consequently, any activity that compromises safety is considered unacceptable and not tolerated as evidenced by case study research within the utilities sector (Wishart & Rowland, 2010). Furthermore, appropriate resources such as training programs, awareness programs and workplace health and safety management teams are allocated to provide assistance and guidance and ensure total compliance. In contrast, when it comes to managing work driving safety, many organisations lack policies relating to driving safety (Haworth et al., 2008) and suffer from being inadequately resourced in terms of personnel and education programs and often attract lower levels of risk management diligence (Wishart & Rowland, 2010; Wishart, Rowland & Davey, 2010). Consequently, a lack of appropriate risk management strategies and diligence toward work related road safety can severely compromise safe driving practices within an organisational context and subsequently increase risk along with the severity and frequency of work related crashes (Stuckey et al., 2010). Therefore to improve work related road safety, organisations will need to prioritise risk management processes and improve the capability of proactively identifying potential drivers at risk. However, as previously discussed, there appears to be a paucity of tools to assist organisations in the risk management process, despite outlining requirements to do so. Therefore, a self-report risk assessment measure could provide a means to facilitate better risk management by fulfilling the gap for industry between the need to improve vehicle driving safety and having tools to assist in the process.

2.9.2 Crash and incident reporting and management

Many organisations in managing the safety aspects associated with their vehicle fleet primarily monitor and assess vehicle and driver safety performance utilising their insurance provider's crash claims data. Unfortunately, as suggested by recent research (Wishart et al., 2011) this approach of safety management is fraught with limitations and negative implications for work related road safety processes. Firstly, reliance on insurance crash data is consistent with a reactive approach utilising lag indicators to manage safety with performance being assessed after the event has taken place (Reiman & Pietikainen, 2012). Furthermore, the use of lag indicators such as crashes becomes particularly problematic if improvements are made which subsequently reduce the frequency of actual crashes (Predictive Solutions, 2012). In other words, if improvements to work driving safety are achieved, the outcome measure (e.g., crashes) decreases, resulting in less data to monitor future performance. For example, Predictive Solutions (2012) conducted a study whereby an organisation reduced actual incidents by 95% annually resulting in a total of 20 incidents to analyse to indicate performance. While the reduction in actual crashes should be commended, the use of crashes as a future measure of safety becomes problematic through attrition of data, now only 20 cases.

Secondly, insurance companies due to the nature of their business are primarily interested in the asset which in this case is a vehicle. Consequently, insurance data rarely contains substantial detail that can aid in the identification of contributing factors to the crash. Consistent with an asset management approach, insurance data contains information regarding the type of crash (e.g., reversing, rear end, merging), cost of damage and subsequent repairs, along with which party is considered primarily at fault. Therefore, insurance data while useful for insurance company and asset management is not without limitations in use for proactively informing organisational driving safety programs (Wishart, et al., 2007).

Thirdly, many insurance policies have a specific crash claim excess which is predetermined at a nominal amount depending on the perceived safety record of the organisation or drivers. For example, many insurance claims may contain a payable excess, typically between $500 and $1500 depending on the organisation and insurance provider. This crash claim excess determines that in the event of an insurance claim the organisation will contribute the amount stated in the excess

toward the cost of repairs for damage. Consequently, many crashes in organisational fleets that result in minor damage not above the excess, often do not constitute an insurance claim and are not often recorded as a crash, but rather as wear and tear at the end of lease (Wishart, Rowland & Davey, 2010). Therefore, if crash data such as insurance records fail to include minor damage incidents, then the data could be a poor outcome indicator resulting in incorrect assumptions relating to driving safety performance (af Wåhlberg , 2009; Wishart et al., 2011).

Finally, research has shown that many insurance claims databases include data fields that contain high frequencies of missing data (Wishart, Rowland, et al., 2011; Wishart & Rowland, 2010; Wishart, Rowland & Davey, 2010). In other words, drivers or persons in charge of the vehicle upon being involved in a crash do not provide adequate information or answers to particular questions contained within the insurance claim form and this missing information is rarely rectified. It is proposed that any analysis or assessment of an organisation's driving performance in regard to their vehicle fleet can only utilise information that is obtained and if data is missing, then any monitoring or assessment of outcomes and performance is severely compromised.

In order to proactively monitor work related driving performance, the development of better lead indicators should not only be encouraged, but be conceptualised as any measure that produces information of interest both qualitatively and quantitatively and be able to identify the deficiencies in safety performance prior to the occurrence (Reiman and Pietikainen, 2012). Consequently, investigating the potential for a work related driving risk assessment measure capable of identifying at risk drivers could be viewed as beneficial in providing organisations with relevant lead indicator measures to better mitigate crash risk.

2.9.3 Organisational culture and safety climate

Organisational culture is an important concept within an organisational setting due to the influence of culture on organisational processes, functions and management (Husband, 2011). According to Robbins et al, (2011) there appears to be widespread agreement that the term organisational culture refers to "a system of shared meaning held by members that distinguishes the organisation from another organisation" (p.466). Therefore organisational culture can be thought of as individually held norms, attitudes, behaviours beliefs and values that when

collectively organised within an entity such as an organisation creates a culture that is in accordance with the norms, values, beliefs and behaviours (Short, Boyle, Shackleford, Inderbitzen, & Bergoffen, 2007).

Within the organisational culture context, safety culture is the shared attitudes, values, behaviours and beliefs that relate to safety (Guldenmund, 2000) and research indicates that organisational culture can have quite an impact and influence on the safety culture within an organisation (Neal, Griffin, & Hart, 2000). Furthermore, ever since the Chernobyl disaster, it has been generally agreed upon that safety culture is a crucial factor exerting influence on safety within organisations (Pidgeon, 1998; Naevestad, 2010).

Along with safety culture, research has also focussed on safety climate and debate often rages regarding the definitions and context associated with each of these terms (Wills et al., 2006; Guldenmund, 2000; Edwards, Davey, Armstrong, 2013). However, although Schein (1992) suggests that safety culture and safety climate are interrelated, the general view is that safety culture is often expressed within an organisational setting through safety climate (Guldenmund, 2000). Within the organisational context, safety climate represents employees' perceptions about organisational support relating to safety and refers and is primarily a psychological concept (Wills et al., 2006). Not surprisingly similar to safety culture, the importance of safety climate and its relevance to organisational safety has been demonstrated across a range of industry settings (Christian, Bradley, Wallace, & Burke, 2009; Nahrgang, Morgeson, & Hofmann, 2008; Flin, Mearns, O'Connor, & Bryden, 2000; Wills et al., 2006). For example, safety climate has been linked to compliance with safety standards in the construction industry (Goldenhar, Williams, & Swanson, 2003); lower occurrence of workplace incidents (Griffin & Neal, 2000); enhancement of safety knowledge (Christian, Wallace, Bradley & Burke, 2009); and predictive of overall work related driving behaviour in a sample of Australian fleet drivers (Wills et al., 2006). Recent research by Bosak, Coetsee and Cullinane (2013) in a hazardous chemical setting provides further indication of the importance and influence of safety climate by demonstrating that when safety is given a priority and management engages in communication and support for safety, employees will engage in less risky behaviours. In addition, their results also indicated that

employees under work pressure as a consequence of production, may compromise safety procedures and engage in risky behaviour.

Within the work related driving setting, recent research by Oz, Ozkan and Lajunen (2010) investigated the relationship between organisational climate and driver behaviour in a sample of 230 male professional drivers. This study operationalised organisational climate utilising two dimensions representing work orientation and employee consideration. Work orientation refers to the importance given by the organisation to the work being done, work results, employee work style and work related task rules. Employee consideration refers to the consideration of individual employee importance, involvement in decision making processes and their importance of adaptation to the organisation. Driver behaviour was operationalised utilising the Driver Behaviour Questionnaire (Parker et al, 2000) and a Positive Driver Behaviour Scale (Ozkan & Lajunen, 2005). The results of this study demonstrated significant differences in high and low levels of work orientation on self-reported frequencies of errors and violations. Furthermore, after controlling for age, exposure, and types of organisation, an interaction effect of employee consideration and work orientation on frequency of violations was found. These results support the premise that organisational culture impacts on driver behaviour and indicates that as drivers perceive their work environment as cost conscious and having suitable time schedules then drivers reported lower frequencies of driving errors and violations. Interestingly, the results did not demonstrate an influence of organisational climate on any positive driver behaviour with the authors suggesting that this result may be due to positive driver behaviours being mostly associated with internal personal factors in contrast to external organisational factors. Furthermore, the authors also suggest that organisational culture is only one of many factors that may be impacting on driver behaviour within a work setting (Oz et al., (2010).

Other research within the Australian context investigated safety climate and work related driving behaviours utilising a sample of 1000 workers within three organisations (Wills et al., 2006). This study operationalised safety climate using Glendon and Litherland's (2001) Safety Climate Questionnaire Modified for Drivers and utilised a modified version of the Driver Behaviour Questionnaire (Lawton et al., 1997) as a measure of driver behaviour. The results of this study indicated that safety climate was predictive of overall work related driving behaviour and that dimensions

of safety climate such as the importance of safety rules, communication of safety issues and management commitment, are predictors of work driving safety (Wills et al., 2006). Consequently, these results provide evidence of the impact and influence of safety climate on the driving behaviour of Australian fleet drivers.

Therefore, given the results of previous research and the influence of safety climate and culture on safety outcomes and driver behaviour, inclusion of items reflecting these concepts should be considered within a self-report risk assessment measure, especially to determine their ability to predict risky driver behaviour outcomes within a corporate fleet setting.

2.9.4 Fatigue management

While fatigue is also an issue within the general road safety context, fatigue management is a particular issue associated with risk within the organisational driving setting. Fatigue is believed to be one of the most important factors contributing to work related crashes (Haworth et al., 2000). External factors such as unrealistic work schedules and shift work can contribute to fatigue along with a variety of internal factors associated with personal health and fitness (Newnam et al., 2002). In addition, contributory factors including long periods awake, inadequate amount or quality of sleep, sustained mental or physical effort, disruption of circadian rhythms (the daily cycle of waking and sleeping), inadequate rest breaks and environmental stresses (heat, noise and vibration) can also exacerbate levels of fatigue (ACRS, 2003). Furthermore, other Australian research has highlighted the effects of fatigue by showing that a person that has been awake for 17-19 hours has performance capabilities similar to being impaired by alcohol to a blood alcohol content equivalent 0.05%, the legal limit in Australia for most drivers (Dawson & Reid, 1997; Williamson, Feyer, Friswell, & Finlay-Brown, 2000). Fatigue related driving is particularly pertinent to driving and increased risk within the work context due to the geographic size of Australia in combination with the requirements of businesses to provide goods and services across the country. Previous research has indicated that in Northern Region of New South Wales more than a third of driver fatigue crashes or near crashes occurred while driving for work related purposes (Fell & Black, 1996). Furthermore, although many organisations appear to have fatigue management plans it is apparent that there are differences between espoused fatigue management plans and what actually happens in regard to fatigue and driving for

work (Davey et.al, 2008; Wishart & Rowland, 2010). The management of fatigue within a work related driving context although challenging, if undertaken well, can subsequently result in decreased driving risk. Therefore, given that fatigue is such an important factor in the contribution to crashes within the work context, items relating to fatigue and organisational management of fatigue should be incorporated within a risk assessment measurement tool utilised to identify at risk drivers in the work context.

2.9.5 Work task design/time pressure

The manner in which an organisation allocates workloads along with the method of valuing and measuring performance can have an influence on an employee's driving capabilities, fatigue and safety (Mooren & Grzebieta, 2010). For example, in an organisation where the employee is renumerated on a performance basis associated with time pressure or sales, an employee may drive more dangerously, for instance speeding, in order to achieve the sales or product delivery goals expected. Furthermore, if the organisation values sales or delivery performance in a higher business capacity than the risk and associated sanctions with an activity such as speeding then this may ultimately encourage the employee to speed. For instance, within some organisations where remuneration is performance based, the costs and penalties associated with traffic violations, such as speeding, may be viewed simply as a cost of doing business. For example, the author of this thesis through involvement working in the work related road safety arena has had organisational personnel confess to weighing up the costs of potential speeding fines against the penalties associated with non-delivery of documentation within a specified time limit that related to a substantial contract. Thus it was acknowledged that a few speeding fines potentially obtained "along the way" was just a cost associated with business, without any concern for the risk associated with dangerous driving behaviour. However, although this instance highlighted a potential issue with work related road safety and speeding it is not known whether this is an isolated case or a common activity within business settings. Additionally, within organisational settings job and task allocation may be at the discretion of management which may result in an employee perceiving a distinct lack of control over their work day time schedule and consequently over their ability to drive safely (Adams-Guppy & Guppy, 1995; Dorn & Gandolfi, 2008). Therefore, it is suggested that the allocation

of workloads, time pressure and the manner in which employee workloads are managed has the potential to be detrimental to safe driving behaviour. Conversely, if work task design and time pressure is well managed and safe driving is highly valued within the organisation, (above other areas of job performance), then work task design can reduce time pressure and have a positive influence on work related safe driving. Accordingly, in endeavouring to better understand the underlying factors that may contribute to adverse work driving behaviour, items and procedures that relate to work task design and time pressure should be incorporated within any risk assessment measure and work related driving safety processes.

2.9.6 Mobile phone use and distractions

Mobile phone use and distractions associated with new technology are becoming more prevalent within the general road user community living within today's modern world (CARRS-Q, 2012). However, within an organisational setting, mobile phone use and potential distractions in combination with the advancement and implementation of further modern technology is particularly problematic as these components of technology have been thoroughly integrated within the work place and subsequent work place processes (Nurullah, Thomas, & Vakilian, 2013; Australian Bureau of Statistics, 2011). In other words, the use of mobile phones and other technology such as global positioning systems (GPS) have become a key component of doing business, especially within a competitive business environment (EASHW, 2011; Stuckey, La Montagne, Glass & Sim, 2010). For example, many fleet operations utilise technology such as GPS as a tool used for the allocation of jobs, especially in service oriented industry such as taxi's, communication providers, and freight and courier services.

Within all jurisdictions in Australia it is illegal while driving to use a hand held mobile phone for a phone call or to text message (Pennay, 2008). Drivers are however, currently permitted under the legislation to use a mobile phone utilising blue tooth technology or hands free despite compelling research evidence indicating that this method of use is not significantly safer than hands free use (McEvoy, Stevenson, McCarrt, Woodward, Haworth, & Palamara 2005; Redelmeir & Tibishirani, 1997; Svenson & Patten, 2005; Tornros & Bolling, 2005). In regards to crash involvement, early research conducted by Redelmeir and Tibishirani (1997) determined that the risk of crash involvement while using a mobile phone was likely

to be four times higher in comparison to not using a mobile phone. Other later research, based on the observation of drivers utilising in vehicle cameras, indicated a crash risk of up to 23 times more likely if drivers were manually manipulating their phone for phone calls or texts messages (Virginia Tech Transportation Institution, 2009).

Despite the obvious risks associated with using mobile phones while driving, it is apparent that people still combine both tasks. For example, in a large scale Australian study for the Australian Transport Safety Bureau, almost two thirds (61%) of the 1592 participants reported using their mobile phone while driving (Pennay, 2008). In order to better understand the mobile phone use and driving phenomenon, research has begun to investigate factors influencing the use of mobile phones while driving. In a recent study by Zhou, Rau, Zhang and Zhuang (2012), compensatory decisions within the theory of planned behaviour were investigated to determine why people use mobile phones while driving. The results of this study demonstrated that attitudes, subjective norms, perceived behavioural risk and control and prior answering behaviour were all common predictors of answering mobile phones while driving. Other research has suggested that age, gender, annual kilometres travelled, occupation, driver self-image in regard to perceptions of driving skill and the level of safety orientation of drivers can influence whether or not a driver engages in mobile phone use while driving (Poysti, Rajalin, & Summala, 2005).

Further research investigating factors influencing intentions to use a mobile phone while driving, indicated factors such as age, driving purpose, attitude and subjective norms were significant predictors (Walsh, White, Hyde, & Watson, 2008). In this study, the researchers found that younger drivers and business drivers were more likely to intend using a mobile phone while driving, and across a range of different scenarios, drivers with a positive attitude toward using mobile phones were more likely to intend to undertake this type of activity. Furthermore, in relation to subjective norms, drivers who perceived others approving of them using their mobile phone while driving were also more likely to intend to use their mobile phone to make phone calls. It is suggested that the results obtained in this study contain important implications for organisations and work related driving safety, particularly in regards to results demonstrating that those driving for business were more likely to intend using mobile phones while driving and also in relation to drivers perceiving

others approving of them to use the mobile phone. In other words, if a driver driving for work perceives an expectation from other people such as a boss or colleague to use a mobile phone while driving, then they may be highly likely to engage in this unsafe activity. A further important factor for consideration to work related driving obtained from the results of the Walsh et al., (2008) research is the results demonstrating that in general, consideration of the risks associated with driving and using a mobile phone will not necessarily deter drivers from planning to undertake this activity.

The overall implications of research regarding mobile phone use while driving would suggest that despite the risks associated with this practice and the resultant impairment to safe driving ability, drivers especially within a work context will likely continue to use mobile phones while driving. Therefore, in the context of future work related road safety research, mobile phone users while driving for work could be considered more at risk and strategies to minimise this risk require particular consideration. For this reason within an organisational context, an indication of the prevalence of mobile phone use while driving can establish the relevant at risk drivers, such that strategies can be implemented toward prevention.

In summary, although driving for work activities are undertaken within the general road network, there are a range of various influences within organisational settings such as organisational culture and safety climate, work load design and time pressure, risk management, fatigue, and mobile phone use that appear to impact on work related driving. Furthermore, indications from previous research outlined in this chapter indicate that many of these factors have the potential to exacerbate the risks associated with work related driving. Within an Australian organisational setting, there is increased responsibility as outlined within the legislation to undertake improved risk management processes to mitigate work related driving risk. In addition, risk management must be undertaken in a proactive manner through the identification of potential hazards and risk. A self-report work related driving risk assessment measure that incorporates organisational and contextual factors identified within this chapter that influence work driving behaviour has the potential to provide organisations with a tool capable of identifying at risk drivers, and subsequently progress toward meeting risk management requirements and improving work driving safety.

2.10 POTENTIAL DETERMINANTS OF WORK-RELATED CRASHES AND INJURY ASSOCIATED WITH POLICY ENVIRONMENT, LEGISLATION, AND PUBLIC POLICY

As depicted in the final level of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007), legislation at the local, national, and international level has the potential to influence work driving behaviour. In relation to risk management practices and intervention strategies, current legislation within Australia outlines the necessary obligations required of not only organisations, but also individuals associated with work driving activities. In addition, each state and territory within Australia has recently undertaken a process to harmonise and adopt consistent workplace health and safety legislation on a national basis through the development of a model Work Health and Safety (Safe Work Australia, 2012c). The overall strengthening of this legislation provides the impetus to force improvements to safety within the work related driving domain, particularly relating to obligations to proactively manage risk.

In Australia, legislation relevant to work related road safety encompasses legislation that may incorporate Acts, Regulations, and Codes of Practice at either state or national levels of jurisdiction. Within each state and territory, legislation relating to occupational health and safety aims to impose obligations to ensure the safety of workers and others at or within a workplace. This legislation, when used in conjunction with other relevant legislation, regulations and codes of practice, aims to minimise risk of harm from hazards that may result in injury, illness or death within the workplace. Furthermore, there are ample court judgements that demonstrate that an employer can be held liable, through not discharging obligations and not ensuring a safe system of work in relation to motor vehicle use for work. Related cases include: *Manning v Taroom Shire Council & Ors* [1994] QCA 430; *Suncorp Insurance & Finance v Workers Compensation Board of Queensland* [1990] 1 Qd.R. 185; *Curtin bros, (Qld) Pty Ltd v. FAI General Ins Co* [1995] 1 Qd.R. 142; *McEwan v. Gold Coast City Council* [1987] 1 Qd.R. 337; *Brew v. Workcover Queensland* [2004] 1 Qd.R 621; *Dredge v South Australia* [1994] 19 MVR 41. In each of the cases listed above, court decisions demonstrated negligence on the part of organisations and/or management to ensure safety by discharging the necessary obligations by organisations to ensure worker safety in relation to activities associated with vehicle use. For example, the *Dredge v South Australia* case

demonstrated negligence of duty of care on the part of the employer in regard to an employee falling asleep while driving for work on shift, whereby the person in charge was aware the employee had been sleep deprived due to inappropriate work rostering.

To provide insight into the relevant legislation and the manner in which it applies not only to organisations, but also workers and workplace activities associated with driving a vehicle for work within Queensland, a list of the relevant legislation and a description of the manner in which it is applicable is detailed below. Firstly, the types of legislation that may be applicable to organisations and work related road safety are as follows:

- Work Health and Safety Act 2011
- Work Health and Safety Regulation 2011
- Transport Operations (Road Use Management) Act 1995
- Transport Operations (Road Use Management Accreditation and Other Provisions) Regulation 2005.

The Codes of Practice applicable to organisations and work related driving include:

- AS/NZS ISO 31000: 2009 Risk Management Principles and Guidelines
- Australian Design Rules and Standards such as Motor Vehicle Standards Act 1989
- ISO 390001: 2012 Road Traffic Safety Management Systems-Requirements with Guidance for Use.

Secondly, the manner in which workplace health and safety legislation can be applied to work related driving is outlined as follows:

The Work Health and Safety Act (2011) outlines the necessary legislative obligations for all parties involved in work processes to provide for a balanced and nationally consistent framework for securing the health and safety of workers and workplaces. The underlying principle is that all workers and other persons should be given the highest level of protection against harm to their health, safety and welfare from hazards and risk, arising from work and work processes. According to the Work

Health and Safety Act (2011), a workplace is "a place where work is carried out for a business or undertaking and includes any place where a worker goes or is likely to be while at work" and includes "a vehicle, vessel, aircraft or other mobile structure" (p.22). Furthermore, "a person is a worker if the person carries out work in any capacity for a person conducting a business or undertaking" and also includes "employees, contractors, volunteers, outworkers, and students undertaking work experience" (p.21). In addition, the Act binds all persons and ensures that persons conducting a business or undertaking must exercise due diligence (pp.29-31).

The Work Health and Safety Act (2011) also outlines the health and safety principles and duties that apply and includes a component on risk management which imposes duties requiring persons to ensure that risks are eliminated as far as practicable and that if it is not practicable to do so to then minimise those risks so far as is reasonably practicable. The Work Health and Safety Act (2011) also defines the requirements for reporting a notifiable incident, which includes the death of a person, or a serious injury which is an injury requiring hospital treatment, illness, or dangerous incident. Interestingly, although the requirements would include many vehicle related incidents due to the nature of the incident, in contrast to the legislative requirements, anecdotal evidence obtained across a variety of organisational fleet settings would indicate that these incidents are rarely reported in this manner. It remains unclear as to whether this is due to a lack of knowledge or ignorance of the legislation, and/or the applicability of the legislation to the fleet setting.

The newly applicable Health and Safety Regulation (2011) formally outlines risk management and workplace management processes and activities that are now a requirement. The risk management processes clearly distinguish each step required in order to identify, manage and systematically control risks in a workplace. It should be noted that in order to strengthen the new regulations, a previous step relating to risk assessment has deliberately been omitted. Previous regulations included a step that enabled a risk to be assessed and if the risk was considered minimal there was the potential for the risk mitigation processes to be ignored. In accordance with new legislation, no longer in the Australian work environment can a person simply conduct a risk assessment, subjectively decide the risk is minimal, and as a result not implement any manner of control to mitigate risk. New legislation states that even minimal risk must be addressed. Therefore, this revised focus has increasing

implications and relevance to work related road safety, especially with regard to organisational requirements to implement better risk management practices in a work vehicle and related driving activities. Finally, the Health and Safety Regulation (2011) clearly outlines requirements for an organisation or undertaking to provide training and instruction in the activities associated with the worker performing their role. In regards to organisational work driving risk assessment, this requirement indicates that no longer can an organisation presume knowledge and capability, but must now provide some training and instruction within their organisational risk management strategies to assess and mitigate risk. Given the lack of suitable work driving risk assessment measures, the development of such a measure applicable to the Australian light vehicle fleet setting may assist organisations in meeting regulation requirements.

In regard to the requirement now to undertake risk management practices within the workplace, the AS/NZ ISO 31000: 2009 clearly establishes a number of principles that are required to be satisfied in order to achieve minimum acceptable requirements for risk management. This standard can be used in conjunction with legislation such as the Work Health and Safety Act (2011) to ensure necessary obligations in legislation are discharged. Consequently, this standard can be utilised as a minimum requirement to demonstrate compliance (or non-compliance) with a predetermined set of requirements and activities to effectively manage and mitigate risk. Although organisational fleet operations may elect to ignore the principles outlined within this Australian and New Zealand Standard, in the event of an unfortunate event such as a serious crash, the principles outlined within the standard could be used to demonstrate the organisation has failed to meet minimum safety and risk management standards.

The AS/NZ ISO 31000: 2009 also makes recommendations that organisations should have a framework that integrates many risk management processes into all facets of the organisations policy, planning, management, reporting, values and culture. This standard particularly outlines key concepts associated with risk management and work related road safety by incorporating principles stating that: risk management is not a standalone activity separate from the main organisational activities; is systematic and structured in its approach; is tailored to be aligned with the organisations risk profile in both internal and external context; and is responsive

to change especially as new risk are identified or emerge. The AS/NZ ISO 31000: 2009 also outlines within a risk management framework, processes associated with policy development, accountability, integration, and the supply of appropriate resources. The detailed framework and the key processes outlined within this document now make it unacceptable for organisations and operators of vehicles used for work, to not possess the knowledge or to be ignorant of risk management processes. In regard to this thesis, the AS/NZ ISO 31000: 2009 now clearly outlines minimum requirements regarding proactive risk management associated with work vehicle use. However, although these risk management processes are outlined, there currently exists a lack of risk management tools to assist organisations in assessing work driving risk within their vehicle fleet settings.

Recently the International Standard ISO 39001 Road traffic safety management systems (2012) was released providing a specific tool to assist organisations to better manage activities that relate to road traffic crashes. Within this International Standard there are requirements for organisations relating to the development and implementation of road traffic safety policy, development of road traffic safety objectives and action plans outlining the manner in which objectives can be achieved. Additionally, this document also outlines requirements for the continuous improvement of organisational processes relating to road traffic safety and places a focus on management to demonstrate leadership and commitment. There is also a requirement for management to ensure responsibilities and authority is assigned to specific roles and communicated throughout the organisation. Finally, the International Standard ISO39001 outlines requirements for organisations to identify a range of performance factors to assess outcomes and in doing so, utilises a series of risk factors associated with vehicle operations within a road traffic system and explicitly states a number of explicit risk factors for organisations to address. Within the context of the work related road safety setting these include: distance travelled; vehicle type and road user type including whether or not influenced by the organisational activities; the type of service provided by an organisation; intermediate safety outcome factors; safe speed; fitness of drivers including fatigue, distraction alcohol and drugs; safe vehicles; removal of unfit drivers from the road network; post-crash response; and final outcome factors particularly death and serious injury. Although the International Standard ISO 39001 Road traffic safety

management systems (2012) now outlines requirements within a work driving setting, the document fails to include details assisting organisations to firstly, assess the driving risk and secondly, provide a tool with the capability to conduct that assessment process.

Interestingly, much of the legislation and relevant regulation outlined above has been either recently updated or newly introduced, and incorporates a much stronger focus toward proactively addressing risk within an organisational context, including specific requirements associated with vehicle use. Whether this renewed vigour incorporating these aspects are as a result of increased awareness of the high representation of work related vehicle incidents within the general road user environment remains unclear. However, despite legislative frameworks, many organisations underachieve in the proactive application of risk management toward motor vehicle use, especially in comparison to other hazards and risks associated with the workplace (Stuckey, LaMontagne, Glass, & Sim, 2010b). For example, case study research within the utilities sector has demonstrated risk management underachievement in vehicle safety strategies in comparison to other risk and hazards such as electricity (Davey et al., 2008; Wishart et al., 2004; Wishart & Davey, 2004).

Importantly, in contrast to previous legislation, the new Australian legislation now clearly places obligations on organisations, including all parties associated with those organisations' activity, to undertake proactive risk management processes to ensure safety. However, although these obligations are now more clearly defined, the above mentioned documents still fail to provide the necessary instruction, content, knowledge or tools that organisations will require to assess risky work related driving activities.

Consequently, there appears to be a gap within the process of transferring legislative requirements into actual risk mitigation along with the provision of tools to aid in this process, such as a measurement tool capable of identifying higher risk drivers within that work setting. Therefore, there is a need within the work related road safety system for a process to adequately and efficiently identify drivers most at risk within a work setting, in order to mitigate risk, inform intervention strategies and subsequently monitor and assess work related driving performance. Accordingly, consistent with the overarching aim of this thesis, it is suggested that the development and implementation of a self-report work related driving risk

assessment measure that is capable of predicting aberrant driving behaviour could provide a means to address the gap in this current process.

2.11 BARRIERS TO IMPROVING OF DRIVING SAFETY WITHIN THE WORK SETTING

This chapter has previously highlighted the magnitude of the work related road safety issue along with the need for industry and road safety stakeholders to improve driving safety within the workplace. However, despite legislative requirements that all stakeholders involved in the work driving process undertake activities to mitigate risk, there are a number of potential barriers that require consideration if work driving safety is to improve.

Firstly, in regards to occupational health and safety and the legislative framework, it is apparent that work related road safety is currently lagging behind other occupational health and safety activities within the general work setting. For instance, as highlighted earlier in section 2.9.1 of this chapter, within many organisations there is resourcing allocated to address occupational health and safety associated with specific core work activities tasks such as ergonomics, health and wellbeing, and hazardous substances, yet very few organisations adequately resource activities or programs associated with work related driving. As a result, very few initiatives are strategically implemented with a result that, as highlighted in section 2.9 of this thesis, organisations fail to adequately address the safety issues associated with work driving within the organisational light vehicle fleet context. Consequently, the lack of adequate resourcing to mitigate risk within work driving safety contributes to creating a barrier to improving the overall work driving safety within the organisational setting.

Secondly, as highlighted in section 2.10, although legislation outlines risk management requirements, very few tools exist to assist organisations in undertaking processes of work driving safety risk management and the identification of risky drivers. In addition, although research has identified a range of various risk factors across a variety of levels associated with the individual, environment and organisation, the relative strength of these influences individually and the complexities associated with their interaction remain unclear. Therefore, an existing barrier to organisations in implementing risk mitigation strategies for work drivers is

not only the identification of risky drivers, but also determining which risk factors are the major contributors to work driving crashes to target with initiatives.

Thirdly, within many organisations work driving although a risky activity, is often not considered as specific to the work role of many employees, despite the considerable amount of time workers may spend driving. Within many organisational settings time taken by employees to complete activities outside of core work processes are often viewed as unnecessary distractions to their work. As a result, any activities not central to core work roles if undertaken, are expected to be completed efficiently with minimal disruption to work processes. Unfortunately, this can impact on risk assessment processes within the driving setting, as in order to meet these expectations, assessment tools need to be extremely time efficient in their method of administration. However, work driving risk assessment tools also need to be accurate in their assessment if they are to assist in identifying and mitigating risk and improve work driving safety. Consequently, a barrier to risk assessment processes and subsequently improvement of work driving behaviour, is ensuring risk assessment tools incorporate a wide range of potential factors influencing work driving behaviour and are accurate, while at the same time are efficient in administration and do not impact on employee work time.

Finally, a further barrier to improving driving safety within the work setting, as highlighted in section 2.9.2 of this thesis, is the over reliance on lag indicators such as insurance crash records to measure and monitor performance. As highlighted in section 1.4 the over reliance on post incident data such as insurance records is inconsistent with a proactive risk management approach within a work setting. In addition, incident data such as insurance records often lack details associated with underlying contributing factors to crashes. As a result, organisations in attempting to improve work driving safety may implement various intervention strategies that may not address "hidden" underlying contributing factors to crashes. Consequently, to overcome this barrier and improve driving safety within the work setting there is a need to establish a set of lead performance indicators to assist organisations to progress toward a proactive risk management approach.

In consideration of the above mentioned barriers, future research is needed to investigate these issues and develop ways in which organisations and work related

road safety stakeholders can overcome these barriers and improve work related driving safety.

2.12 RESEARCH NEEDS

This chapter has discussed the research literature and current legislation associated with work related road safety. It has also provided an outline of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) which conceptualises a range of potential influences on crashes and associated injury among those driving for work. In addition, this chapter has highlighted a number of gaps in the research that are required to be addressed if work related road safety is to improve, especially within the Australian organisational context.

The literature review contained within this chapter has discussed a wide range of factors influencing work driving behaviour within broader areas of the work context such as the individual, vehicle, road environment, organisational environment and legislative requirements. It is apparent that in regards to work driving safety there are numerous factors of potential influence to driving behaviour that have been identified. Unfortunately, there are gaps in our knowledge regarding the complexities associated with influences on driving behaviour within the work setting. For example, although a reasonable amount of research has investigated many of the influences on driving behaviour, little research has been undertaken within the work driving setting incorporating a comprehensive approach investigating potential influences on work driving behaviour outcomes. Therefore, there is a need in research to undertake an approach that incorporates a wider range of potential factors of influence on work driving behaviour and investigate these factors and their relationship to risky driving outcomes such as crashes.

This chapter has also highlighted developments within various legislative frameworks that clearly establish minimum requirements for organisations, employees and road safety stakeholders to mitigate risk associated with work driving activities. However, if organisations and road safety stakeholders are to improve risk mitigation and work driving safety, then there is a need for research to develop work driving risk assessment tools to assist organisations in identifying at risk work drivers. A further consideration, particularly for industry in the development of work

driving risk assessment tools, is that they are capable of being easily administered within organisational settings.

The review of the literature discussed within this chapter has identified a number of gaps in knowledge, practice and research associated with factors influencing work driving behaviours and risk, risk assessment and mitigation processes. As a result of the gaps identified within the literature, there are a number of important questions relating to work related road safety and risk assessment which remain unanswered. Each of these research questions requiring further attention are discussed below.

2.13 RESEARCH QUESTIONS

Research Question 1. Can previously designed self-report measures predict self-reported crashes and offences within Australian work related driving settings?

Evidence within the literature indicates the need for organisations to better manage and mitigate work related driving risk. However, to achieve better risk mitigation within the work driving setting, a crucial step is for research to develop a work driving risk assessment tool that will be capable of being used by organisations to identify risky drivers and address unsafe driving behaviours. As a means to better understand work driving safety and driver behaviour, research commonly utilises self-report measures such as; the Driver Behaviour Questionnaire (Reason et al., 1990); and Safety Climate Questionnaire Modified for Drivers (Glendon & Litherland, 2001; Wills et al, 2004). However, in regards to improving work driving risk management, little evidence exists attesting to the ability of previously designed self-report measures to predict risky work driving behaviour outcomes such as crashes and offences. Therefore it is critical to answer the first research question by investigating the ability of previously designed measures to predict self-reported crashes and offences as a means of determining their suitability for inclusion in future work driving risk assessment development.

Research Question 2. What are the predominant factors that drivers believe influence driving behaviour within work related driving settings?

Previous research has provided evidence attesting to the wide range of complex factors that influence driver behaviour. Within the work driving setting, the

complexities of these factors increase due to associations between the organisational environment, workplace health and safety, transportation and general road safety. To date, there has been little research investigating the predominant factors that drivers believe influence their work driving behaviour. It is important in the development of a work driving risk assessment measure to consider the inclusion of factors not only identified and conceptualised by research, but also develop an assessment measure that encapsulates factors associated with driver beliefs.

Research Question.3. Can environmental, organisational, and driver related factors that influence work related driving predict crashes and offences within a fleet environment?

Although evidence attests to the wide range of factors influencing work driving behaviour, there is a need for research to examine the strength of association between these factors and risky driving outcomes. In addition, a work driving risk assessment measure must incorporate the range of items necessary to reliably identify drivers with increased levels of work driving risk. A work driving risk assessment measure in order to be valid and useful to industry, must be capable of predicting risky work driving behaviour outcomes such as crashes and offences.

Research Question 4. Can a newly devised work driving risk assessment measure identify risky drivers by predicting crashes and traffic offences within the Australian work driving context?

Legislation clearly outlines the requirements within organisational work driving settings to manage and mitigate risk. Research outlined within the literature, has highlighted that one of the difficulties faced by organisations in meeting these requirements is a distinct lack of a work driving risk assessment measure that can be used to identify drivers more at risk. Therefore, an important step in research is to develop a work driving risk assessment measure that incorporates factors that influence driver behaviour and assess the measures capability to predict risky driving behaviour outcomes such as crashes and offences within a work driving fleet context.

2.14 CHAPTER SUMMARY

In summary, this chapter has outlined the current situation of work related road safety primarily within the Australian context highlighting the overrepresentation of work driving crashes and the difficulties associated with addressing this issue. The

Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) has identified a wide variety of potential influences on work driving outcomes across a variety of levels incorporating factors at the personal and individual level, immediate external environment primarily related to the vehicle, external road environment, organisational environment and legislative frameworks. This chapter then utilised the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) as a framework to discuss the relevant literature and research relating to work driving behaviour. It is apparent from the research outlined within this chapter that there are numerous risk factors that potentially contribute to driving safety and particularly work driving behaviour. Furthermore, the manner in which these influences interact with work driving safety remains unclear and further research is required to better understand the complexities associated with the vast array of potential influences on work driving crashes and injury.

There are a number of key points underpinning this current research that were outlined within this chapter that are worth reiterating.

Firstly, previous research discussed within this chapter indicates that despite the over representation of fatalities and injuries associated with work related driving, evidence suggests that work related road safety appears to have "slipped under the radar" within organisational risk management processes.

Secondly, recent changes have been made to legislation to now incorporate work related road safety and outline obligations and processes now required to minimise and manage risk. However, given much of the legislation is in its infancy, at this time, it remains unclear as to the manner in which this can be accomplished. Furthermore, although the legislation is clear regarding obligations and requirements to thoroughly manage risk associated with work related driving, the legislative framework does not provide the required tools to facilitate proactive risk management within the work driving setting. Consequently, there is a gap in the development of research informed assessment tools capable of being utilised by organisations to proactively identify and subsequently manage work driving safety risks. Therefore, as a means of addressing this gap and consistent with the overall aim of this thesis to contribute to improving work driving safety and risk management, an initial step is to investigate factors associated with driver behaviour and work driving risk, along with developing a mechanism capable of proactively

identifying drivers “at risk”. Such a mechanism would also provide further benefit to organisations by better informing intervention initiatives that can be utilised to subsequently reduce work related road trauma.

Chapter 3: Towards the Development of a Work Related Driving Risk Assessment Tool

3.1 INTRODUCTORY COMMENTS

The previous chapter highlighted the extent of the work related road safety problem, the factors believed to influence unsafe driving behaviour and the need to address the work driving safety issue. Although there is a legal, economic and social requirement to reduce road crashes within workplace settings, there is a gap in the knowledge regarding the complexity of factors contributing to crashes within the work driving setting. In addition, despite legislative requirements for industry to undertake risk mitigation strategies, there is a gap in current practice associated with the lack of an empirically-based work related driving risk assessment measure. Consequently, there is a need not only to develop a work driving risk assessment measure to address this identified gap, but also to empirically evaluate such a measure. This chapter will outline a range of considerations relating to the development of such a measure, including the inherent difficulties involved in predicting human behaviour particularly through the use of self-report instruments.

3.2 THE PREDICTABILITY OF BEHAVIOUR

Psychology as a science endeavours to better understand and explain human behaviour not only at an individual level but also in relation to interactions with other individuals and the various contextual environments humans interact within (Robbins et al., 2011). Although many undergraduate psychology students are taught that past behaviour predicts future behaviour (Ouellette & Wood, 1998), research has consistently demonstrated that predicting human behaviour is actually quite difficult (Robbins et al., 2011). Research has established a variety of reasons for these difficulties including; individual differences (Robbins et al., 2011); situational circumstances and the changes associated with a dynamically changing environment (Cziko, 1989); inaccuracy of assessment and research methodologies (Dawes, Faust, & Meehl, 1989); and biases associated with self-assessment (Diekmann, Tenbrunsel & Galinsky, 2003). Despite the difficulties of predicting human behaviour, humans

tend to be “creatures of habit” and thus express tendencies to develop patterns of repetitive responses to stimuli and subsequent actions (Ouellette & Wood, 1998). Consequently, research efforts continue to focus on the development of methodologies and assessment measures to accurately predict human behaviour (Robbins et al, 2011). This research is evidenced across a wide variety of domains including road safety (Dorn et al, 2010); risk taking (Szrek Chao, Ramlagan & Peltzer, 2012); economic behaviour (Traut-Mattausch, Frey & Peus, 2008); organisational behaviour (Robbins et al, 2011); and forensic psychiatry and psychology (Gray, Taylor, & Snowden, 2011).

3.3 PHILOSOPHY OF ASSESSMENT VERSUS SCREENING

While there are many different theoretical approaches to identifying individuals who have outstanding needs and/or are at risk of experiencing negative outcomes, these approaches can be broadly categorised as either screening or assessment procedures. Screening procedures most commonly involve administration of a short often “norm referenced” set of questions or items that comprise a checklist to assist in the evaluation of a person’s ability or behaviour as well as the identification of potential difficulties associated with that ability or behaviour (American Psychological Association, 2014). In contrast, assessment processes involve a more comprehensive program which may consist of numerous components including norm referenced tests, interviews, observational data, and medical evaluations (American Psychological Association, 2014). According to Williams (2008), screening tools are often used in the identification of individuals at risk as well as to establish those who would likely benefit from more in depth assessment. The purpose of undertaking a further in depth assessment is to obtain a thorough assessment of individuals which may not only display a range of underlying characteristics but also provide comprehensive information to inform intervention strategies (Williams, 2008).

Screening tools and assessment measures are used across a variety of domains including clinical, occupational health and safety, forensic and legal settings. Within clinical settings, although screening tools aid in initial diagnosis, a complete assessment is more commonly undertaken to provide thorough baseline data across a variety of factors which can be utilised for comparing changes over time (Australian Psychological Society, 2014). Within the occupational health and safety domain,

risk assessment processes tend to be more operational in nature with relevant checklists specifically utilised to identify hazards and subsequently mitigate risks (AS/NZ ISO 31000, 2009). Within legal settings a variety of instruments and assessment methods have been developed to assist in the evaluation of competency to stand trial (Zapf & Viljoen, 2003). Within the forensic field, a range of actuarial tools have been developed to aid in the assessment of risk associated with criminals reoffending (Walters, 2011). Popular tools such as the Alcohol Use Disorders Identification Test (AUDIT) developed by Babor, Higgins-Biddle, Saunders & Monteiro (2001) have also been used within road safety research settings to identify alcohol use disorders (Refer Jia, King, Sheehan, Fleiter, Ma & Zhang, 2013). However, although debate continues across settings as to the benefits of using these instruments, evidence indicates that assessment and screening tools can make a valuable contribution to evaluation procedures (Zapf & Viljoen, 2003).

In regards to the current program of research, the measure requiring development is designed to be a work driving risk assessment measure focusing on a wide range of potential influences on work driving behaviour. This approach is required due to the wide range of complexities associated with the task of driving. Consequently, the measure being designed will not be conceptualised as a simple audit tool as it is believed that such a tool would not encompass the vast range of potential issues of influence in the work driving fleet environment. However, it should be noted that due to a number of industry considerations explained in detail later in this chapter, the measure was not be designed to incorporate multiple processes (e.g., stages) of assessment such as interviews, observations, and in-vehicle assessments. In contrast, to assist in meeting industry needs the work driving risk assessment measure was designed to involve one assessment process for participants.

A work driving risk assessment measure that is self-report in nature may offer a number of potential advantages to research and industry. For example, the use of a self-report risk work driving assessment measure can include an assortment of items designed to represent potential factors believed to influence work driving behaviour. In addition, a self-report measure offers advantages to industry in that the assessment tool can be easily administered within an organisational setting especially as administration only involves one assessment process.

Although the process of utilising self-report data to predict risky behaviour has been criticised (af Wåhlberg, 2011), self-report measures have been successfully used within settings other than road safety (Walters, 2011). For example, self-report measures have been used effectively within particularly high risk behaviour settings such as criminal populations to predict offender recidivism and risky behaviour (Walters, 2011). Therefore to provide some further indication as to the validity of the use of self-report measures in particular populations, the next section briefly discusses the application and validity of self-report assessment to predict high risk behaviour within the forensic setting.

3.4 SELF-REPORT ASSESSMENT TO PREDICT RISKY BEHAVIOURS IN FORENSIC SETTINGS

In attempting to improve the accuracy of measures and methodologies utilised to predict human behaviour, researchers continue to debate the accuracy associated with self-report assessment measures versus other risk appraisal and screening techniques. For instance, clinicians conducting forensic evaluations with offender populations are often wary of relying on self-report data due to the potential for respondent deception (Edens, Hart, Johnson, Johnson & Olver, 2000). However, according to Walters (2011) much of this concern may be somewhat misplaced given that self-report has demonstrated success in predicting risky behaviours such as violence and recidivism within institutional settings. Walters (2011), further suggests that many risk appraisal procedures such as the Psychopathology Checklist Revised/Screening Version (Hare, 2003) and the Violence Risk Appraisal Guide (Hart, Cox & Hare, 1993) have been shown to be superior to broad non-crime specific scales such as the NEO Personality Inventory Revised (Costa & McCrae, 1992). In addition, self-report measures such as Psychological Inventory of Criminal Thinking Styles (Walters, 1995) and Self Appraisal Questionnaire (Loza, Dhaliwal, Kroner & Loza-Fanous, 2000) have also produced results consistent with other risk assessment procedures. Consequently, Walters (2011) suggests that self-report measures have their role and in some instances may demonstrate superior abilities to other types of assessment especially in regards to specific content areas such as determining a person's beliefs and attitudes. Therefore, given the link associated with beliefs, attitudes and driving behaviour in road safety (Azjen, 1991) and the validity of self-report in predicting risky behaviours in other settings such as forensics,

(Walters, 2011) it is argued that self-report measures may have an important role in road safety and particularly work driving and risk assessment.

3.5 THE ROLE OF SELF-REPORT MEASURES IN ROAD SAFETY

Within the road safety setting, self-report measures have been the most extensively utilised data collection method as a means of creating a better understanding of traffic safety research (af Wåhlberg, 2009). In addition, af Wåhlberg (2009), states that it is likely that self-report data is so commonly used for reasons such as; the ease and relative lack of expense in comparison to other research methods associated with data collection; the large quantities of data can be obtained; and almost any question can be asked representing a cross section of concepts across a variety of constructs.

Consequently, researchers have developed and utilised a number of self-report measurement tools to explore relationships between factors influencing driver behaviour and contributing to crash involvement. Three self-report measures commonly utilised across a variety of road safety research settings are the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005). These are briefly reviewed below.

3.5.1 Driver Behaviour Questionnaire

The Manchester Driver Behaviour Questionnaire (DBQ) is the most widely used self-report measurement scale to examine self-reported driving behaviours (Martinussen, Hakimies-Blomqvist, Moller, Ozkan, & Lajunen, 2013; Lajunen, Parker & Summala, 2004; af Wåhlberg, 2009). The DBQ has primarily been used in road safety settings to predict self-report crashes and originated in accordance with Reason's error theory as a tool to measure aberrant driving behaviours with the intended use of predicting traffic crashes (af Wåhlberg et al., 2011). Consequently, the use of the DBQ and items within the measure to predict traffic crashes requires consideration in accordance with the overall aim of this thesis in developing and testing a new driver risk measurement tool for use by organisations.

The DBQ has been extensively utilised in a range of driver safety research areas, such as: different driver groups (Martinussen et al., 2013), age differences in driving behaviour (Dobson, Brown, Ball, Powers, & McFadden, 1999), the genetics

of driving behaviour (Bianchi & Summala, 2004), cross cultural studies (Warner, Ozkan, Lajunen & Tzamalouka, 2011; Lajunen, Parker & Summala, 2004) as well as factors contributing to accident involvement (Dobson et al., 1999; Parker et al., 1995) and demerit point loss (Davey, Wishart, Freeman & Watson, 2007). Furthermore, the versatility of the DBQ has also been demonstrated via the utilisation of the instrument in a number of countries, including Qatar and the United Emirates (Bener, Ozkan & Lajunen, 2008), China (Xie & Parker, 2002), Australia (Davey, Wishart, Freeman, & Champness, 2006; Dobson et al., 1999; Newnam, Watson & Murray, 2004), New Zealand (Sullman et al., 2002), Finland (Bianchi & Summala, 2004), and the United Kingdom (Parker et al., 1995; Parker, McDonald, Rabbitt, & Sutcliffe, 2000).

The popularity of the DBQ to assess current driving behaviour is also reflected in the considerable evolution of the scale since its inception. The original DBQ was developed by Reason et al. (1990) and focused on two distinct driving behaviours that were identified as *errors* and *violations*. Errors were believed to consist of actions that are not planned (e.g., mistakes and misjudgements), while violations were considered to be deliberate deviations from safe driving behaviours (e.g., speeding). However, an additional factor referred to as "slips and lapses" was also developed that focused on attention and memory failures, which were traditionally not considered to affect overall road safety. Specifically, such behaviours were associated with attention and memory problems, while errors include more serious mistakes such as failures of observation and misjudgement (Lajunen & Summala, 2003).

The original DBQ scale has undergone further modification by Lawton et al., (1997), incorporating additional items to assess other factors that have been proposed to contribute to driving violations. For example, aggressive violations items have been included in the questionnaire and focus on an interpersonal aggressive component such as showing or exhibiting frustration. However "ordinary" violations remained within the scale and consist of aberrant driving behaviours that do not have an aggressive aim e.g., speeding behaviours. Taken together, currently the scale distinguishes between two forms of violations that are *Highway code violations* (e.g., speeding & running red lights) and *Interpersonal aggressive violations* (e.g., chasing another motorists when angry & sounding one's horn). A closer examination of the

definitions reveal that highway code violations focus on gaining an advantage such as speeding and engaging in risky overtaking manoeuvres while aggressive violations are more hostile in nature and are usually directed towards other motorists.

In addition to the considerable level of modification of DBQ items, there has been a high level of variation within the literature regarding the number of factors identified from using the DBQ. Firstly, some earlier research confirmed the original three factors of *errors, violations* and *lapses* (Aberg & Rimmo, 1998; Blockey & Hartley, 1995; Parker et al., 1995). For example, Aberg and Rimmo (1998) identified inattention and inexperience error factors from a large group of Swedish drivers, but overall found the same factor structure. In contrast, there has been evidence of four factors reported by Sullman et al. (2002) that focused on *errors*, *lapses*, *aggressive violations* and *ordinary violations*. Similarly, Lajunen, Parker and Summala (2004) identified four factors with a group of UK drivers, and Mesken Lajunen, and Summala (2003) reported four factors (*errors, lapses, speeding & interpersonal violations*) when examining the driving behaviours of Finish motorists. In addition to the different number of factors identified, research has generally reported differences in factor structure, as specific items often load on different factors depending on the driving context (Davey et al., 2006), which ultimately influences the naming and interpretation of each factor. Recent research has also suggested that within an Australian setting there appears to be some overlap between acts of aggression and highway violations indicating that instances of highway violations may also contain certain aspects of aggression (Davey, et al., 2007). Other research has also indicated that other issues such as fatigue and multi-tasking, distraction and concentration should also be considered as they appear extremely relevant to Australian fleet settings (Freeman, Davey, & Wishart, 2007). Furthermore, although the Driver Behaviour Questionnaire is the most utilised questionnaire within road safety research (af Wåhlberg , 2009), indications are that modifications to existing items and sub scale structure may be required to have self-reported behavioural items more suitable and applicable within the Australian context (Freeman et al, 2007; Davey et al, 2006). Therefore, development of a self-report work driving risk assessment measure applicable to the Australian context should consider investigating the inclusion of Driver Behaviour Questionnaire items and subsequently determine their relationship with risky driving behaviour outcomes.

3.5.2 Driver Attitude Questionnaire

Another measurement tool that is beginning to receive increasing attention within the road safety literature is the Driver Attitude Questionnaire (Parker et al., 1996). The DAQ was developed by Parker et al. (1996), as a self-report measurement tool designed to measure overall driver attitudes towards the commission of violations. Items within the DAQ focus on four distinct factors representing respondents' attitudes towards major driving issues of drink driving, following closely to other vehicles, risky overtaking & speeding. Given the link between attitudes and behaviour in road safety (Azjen, 1991) and the inclusion within the DAQ of some of the major factors impacting on the safety or drivers, exploration regarding the use of the DAQ in this program of research appears warranted.

Research has begun to utilise the DAQ within a number of different applied settings such as: speed awareness training (Meadows, 2002), general driver training programs (Burgess & Webley, 2000), bicycle interventions (Anderson & Summala, 2004), as well as more recently in work-related settings (Davey et al., 2006; Wishart et al., 2006). Preliminary research indicates that the DAQ has the potential to be implemented to investigate motorists' attitudes towards key road safety behaviours, with motorists generally reporting the most lenient attitudes towards speeding violations (Davey et al., 2006; Meadows, 2002). Other research conducted by Burgess and Webley (2000) incorporated the DAQ as a measurement scale into a driver education program and reported that individuals were most likely to indicate the highest level of intolerance towards drink driving behaviours, followed by close following, and then dangerous overtaking, while participants were least concerned about speeding violations. Meadows (2002) utilised the Attitude toward speeding subscale of the DAQ to assess the effectiveness of a speed awareness training course. The attitude toward speeding subscale demonstrated moderate reliability of .69 before the course and .65 post course. However the research results indicated a significant effect in changes to driver's attitudes toward speed following completion of the course.

Other research has utilised the DAQ in combination with a number of self-reported driving assessment questionnaires (e.g., DBQ & Climate Safety Questionnaire) to investigate the driving behaviours of 443 fleet motorists in a sample of Australian fleet drivers (Wishart, Davey, & Freeman, 2006). Reliability of

each of the subscales ranged between .51 and .65 with results indicating that participants were more likely to report that drink driving was unacceptable. The next highest factor was close following, followed by attitudes toward risky overtaking. The least highest factor was attitude toward speeding which suggested that participants were more likely to report an acceptance that it is ok to speed. These results suggest that within a sample of Australian fleet drivers it is less acceptable to drink and drive but more acceptable to speed while driving for work. It is also suggested that within an organisational setting, if drivers' attitudes reflect an acceptance of speeding, then this acceptance may be consistent with perceived work allocation or time pressure schedules. Not surprisingly, in regards to predicting risky driving behaviour, drivers' attitudes to speeding predicted demerit point loss over and above annual kilometres travelled within the sample. It is suggested that further research may enhance the development and application of attitude type questions and that this research may also assist in identifying underlying assumptions associated with work related driving which in turn can inform intervention initiatives. Consequently, the use of the Driver Attitude Questionnaire within the first part of this thesis will provide an opportunity to better understand driver attitudes associated with work driving behaviour along with exploring links between attitudes and risky work driving outcomes.

3.5.3 Safety Climate Questionnaire

Safety climate is one type of climate that can be experienced by individuals within a workplace and refers to an employee's individual perceptions of safety in relation to the processes practices, procedures and rewards experienced within the organisation (Griffin & Neal, 2000). Safety climate is a construct that has been utilised in research in recent years and it is suggested that measuring safety climate may be useful to indicate changes in organisational safety behaviour (Glendon & Litherland, 2001). The origins of the Safety Climate Questionnaire relate back to research conducted by Zohar (1980) which explored the identification of organisational characteristics that were evident in organisations with successful safety programs. The intended purpose of such an instrument was to provide a self-report measurement tool to discriminate between high and low rate accident companies (Zohar, 1980). In accordance with this intention, safety climate scales utilised as a measurement tool have previously demonstrated differences between

sub groups within an organisation and it has been suggested that research results have provided evidence that different safety sub climates do exist within a workplace (Glendon & Litherland, 2001). Therefore, consistent with the aims of this thesis, further exploration of safety climate scales are warranted in regard to the development of a work driving risk assessment measure.

In recent years, safety climate surveys have been utilised within organisations and across cultures and occupations to examine relationships between safety climate and safety outcomes (Banks, Davey & Brownlow, 2006). Previous research utilising safety climate has also demonstrated that an organisation's attitude to safety correlates negatively with accident rates (Varonen & Mattila, 2000). Research by Wills, Watson, and Biggs (2004) has extended the application of safety climate to incorporate work related driving. This research involving "fleet safety climate" has begun to explore links between safety climate, safety outcomes, and interventions designed to deliver safety outcomes within a work related driving context. Results from that study, although indicating that fleet safety climate was a strong predictor of self-reported work driving behaviour, also identified that other safety climate variables such as attitude, driving experience and driving exposure did not predict previous involvement in crashes or traffic offences (Wills et al, 2004).

Previous research across a variety of contexts has identified a multitude of factors relating to various aspects of organisational and safety climate. Some studies have identified up to eight dimensions incorporating concepts such as management attitude, effects of safety conduct on promotion, status associated with safety officer positions, and the pace of work (Zohar, 1980). Other research (Brown & Holmes, 1986) has identified three dimensions incorporating management concern, management action and risk to physical wellbeing, while still other research identified two factor structures indicating concepts such as management commitment and worker involvement in safety (Dedobbeler & Beland 1991).

However, while research has demonstrated different factor structures depending on the size and scope of the instruments used, it would appear that research consistently identifies one particular factor that appears to be common across many studies (Griffin & Neal, 2000). This factor generally relates to employees' perceptions of management values when it comes to safety. Glendon and Litherland (2001), suggest that while research results appear to demonstrate that

some safety factors may remain quite stable across organisations, they suggest that identical safety climate factors may not be applicable across all organisations.

In summary, although safety climate scales have demonstrated various levels of applicability and association to safety outcomes across industry, it is apparent that further refinement of a safety climate measurement tool is required to enhance the appropriateness and practical application to professional drivers within an Australian context. In addition, the use of the Safety Climate Questionnaire in the first stage of this thesis will enable the exploration of a range of safety climate factors and their ability to predict risky driving behaviour outcomes within the Australian light vehicle fleet context.

3.6 THE USE OF SELF-REPORT MEASURES WITHIN THE WORK DRIVING SETTING

Despite some recent criticism of self-report measures (af Wåhlberg, 2009), the utilisation of self-report data continues to remain popular as a means to better understanding driver behaviour and crash involvement (Martinussen et al, 2013). Self-report instruments offer potential for use within work related vehicle settings, particularly as they present an opportunity to explore a variety of concepts relating to driving safety. For example, self-report measures offer the opportunity to explore a range of psychosocial factors associated with driving behaviour along with employee perceptions of driving safety and risk management procedures. In addition, self-report measures offer organisations the opportunity to better understand the vast array of potential factors influencing work driving behaviour which in turn, can be utilised to further inform the development and implementation of intervention strategies within the organisational setting.

Self-report measures have also proven useful within work settings to identify and consequently promote desirable characteristics (such as improved attitudes and driving behaviours) amongst employees driving for work along with identifying organisational training and education requirements (such as employee road rule knowledge) to improve driving safety (Darby, Murray, & Raeside, 2009). It is suggested that the use of self-report instruments in a broad based company approach may provide a cost effective manner to identify risks and improve safety outcomes, which may not have been undertaken due to excessive costs associated with other measurement methods (Darby, Murray, & Raeside, 2009; Wishart & Rowland,

2011). Within a fleet context, Darby and colleagues (2009) utilised self-report data incorporating a wide range of factors such as knowledge of road rules; exposure to risk; driver behaviour and attitudes; and hazard perception; to determine a particular organisation's safety approach associated with vehicle use across a sample of 16,004 work vehicle drivers. Interestingly, in this study the use of self-report data highlighted organisational deficiencies in actual reporting of crashes and consequently, in risk management processes. In relation to factors incorporated in the measure, Darby et al., (2009) determined that there were significant correlations between driver attitudes and behaviours and collision involvement, suggesting that unsafe attitudes and behaviours equate to higher crash involvement. In addition, self-report measures of traits such as aggression, impulsiveness and impatience also appeared to have associations with an increased likelihood of being involved in vehicle crashes.

Further research also indicates that self-report measures may have a role in developing and providing direction in the future improvement of driver training and education programs within an organisational context. Previous research suggests that typical "behind the wheel" skill based driver training provides little long term safety benefits (Struckman-Johnson, Lund, Williams, & Osborne, 1989; Lund & Williams, 1985) or that what is learned during skills based training rarely transfers post training to future safety benefits (Groeger & Banks, 2007). However, improvements in driver education have progressed beyond skills based training and incorporates concepts such as risk taking, own ability evaluation (Sundstrom, 2005) and personal strengths and weaknesses (Vissers, Mesken, Roelofs, & Claesen, 2007). Consequently, self-report measures may serve as a useful tool encouraging drivers to explore concepts such as risk taking, the results of which may improve their own understanding of driving behaviour along with providing trainers with a better understanding of driver issues (Dorn & Gandolfi, 2008).

3.6.1 Recent Developments of Self-Report Fleet Driver Assessment Tools

Within the work driving context, recent research has also endeavoured to enhance the development and utility of self-report measures. For example, Dorn and Gandolfi (2008) attempted to design a psychometrically-based self-assessment measure to address fleet safety risk in UK fleets by assessing the potential for three

instruments to predict driver behaviour with a view to incorporating the three instruments and create one instrument known as the Fleet Driver Risk Index. The study comprised two stages, with the first stage determining the factor structure associated with the three instruments utilised in this study. The instruments were the Driver Stress Inventory, Driver Coping Questionnaire, and 40 newly constructed items developed by the authors relating to risks associated with driving for work. The results of the factor structure in the first stage provided a rationale for the instruments to be incorporated in a new instrument called the Fleet Driver Risk Index. This tool was then administered to a large sample (n=1089) of fleet drivers. The results of this study demonstrated some support for a number of constructs within the newly developed self-report measure. In regards to traffic violations, the results indicated significant positive correlations between measures of thrill seeking and work related risk and the number of infringement points as a result of violation history. Interestingly, drivers with a history of a high level of traffic violations reported higher levels of risk taking as a result of time pressure. In regards to crash involvement, drivers involved in two or more crashes reported higher levels of aggression in comparison to drivers with fewer or no crashes, suggesting that aggression is an indicator of risky drivers. In addition, drivers with three or more crashes reported higher levels of work related risk and reappraisal coping in contrast with other drivers with fewer crashes. These results suggest that within a fleet setting, aggression and work related risk taking, such as time pressure and meeting work demands, contributes to unsafe driving behaviour (Dorn & Gandolfi, 2008). Overall, although the results demonstrated some support attesting to positive psychometric properties of the Fleet Driver Risk Index, the predictive efficacy of the scale is yet to be determined.

Further research conducted by Dorn, Stephen, af Wåhlberg , and Gandolfi (2010) in the development of a self-report measure of driver behaviour also resulted in an instrument specifically designed for UK bus drivers, known as the Bus Driver Risk Index. This research consisted of three studies. The first study involved piloting a questionnaire using a sample of 315 bus drivers to determine the factor structure of the developed questionnaire. The second study assessed the test retest reliability of the scales developed within study one and administered the questionnaire to a sample of 557 bus drivers and then readministered the questionnaire some two to three

months later to a sub sample of 131 bus drivers. The final study attempted to validate the Bus Driver Risk Index utilising a bus driving simulator and measurements of driver celeration behaviour (overall mean speed change) conceptualised by af Wåhlberg (2008). The results of the first two studies indicated that the Bus Driver Risk Index contained items relevant to driving a bus for work and the measure contained fair to good test retest reliability over the three months. However, the results of study three are somewhat limited in regard to the identification of risky driving behaviour and provide an indicator of many of the limitations relating to simulator use and comparison to actual on road driving. Overall, the results demonstrate the complexities of driver behaviour within specific fleet environments and this subsequently highlights the need for further risk assessment measurement development applicable to the fleet settings.

Other research in the development of self-report measures applicable to the driving setting has also investigated concepts associated with safety culture. Safety culture has been identified in previous research as a key predictor of safety performance (Naevestad, 2010; Neal, Griffin, & Hart, 2000; Ostram, Wilhelmsen, & Kaplan, 1993; Pidgeon, 1998). In a recent study, Oz and Lajunen (2008) developed and utilised an Organisational Safety Culture Scale to collect driver's perceptions of the safety culture of the organisation in which they were working. The initial scale consisting of 23 items was factor analysed and subsequently resulted in refining the original scale into 15 items measuring three subscales. The three subscales were conceptualised as "traffic safety" incorporating seven items, "general safety" containing only three items, and "work safety" consisting of five items, and exhibited moderate reliability of .85, .74, and .92 respectively. Correlations indicated a statistically significant positive relationship between the traffic safety and work safety factors (.67, $p < .01$), while general safety had a negative statistically significant relationship with driver crash involvement (-.26, $p < .05$) suggesting the scale has merit. A primary aim of that study was also to investigate the effect of organisational safety culture on driver behaviour. Results indicated that in relation to driver behaviour, the traffic safety dimension was negatively related to violations and crashes and that general safety was negatively related to errors and crashes. None of the three organisational safety factors of traffic safety, work safety or general safety were predictive of self-reported positive driver behaviour. Interestingly, results also

suggested a positive relationship between high levels on the work safety dimension and errors and violations. The authors, in explaining this anomaly in results, suggest that this may have occurred as a result of the organisational culture and subsequently, employees having a high priority for safety, thus encouraging employees to report incidents and hazardous situations. Furthermore, the authors also suggest that an organisation high in safety priorities may also foster a blame free atmosphere and subsequently make it easier for employees to recall and report their driving errors and violations.

Within an Australian context, recent research in the development of self-report measures has resulted in the development of an Occupational Driver Behaviour Questionnaire (Newnam, Greenslade, Newton, & Watson, 2011). According to the authors, the instrument was designed to assess behaviours that are believed to be particularly influenced by the working environment. The Occupational Driver Behaviour Questionnaire incorporates four self-reported behavioural dimensions labelled as speeding, rule violations, inattention and tiredness (Newnam et al., 2011). Initial development and testing of the measure utilised three samples of occupational drivers from within a community based nursing organisation within Australia. The first sample comprised executive level employees (n=14), the second sample consisted of nursing staff (n=1980) who drive work vehicles as a part of their patient care roles, while the third sample (n=829) included additional nursing staff similar to sample two.

While the newly developed instrument possesses sound construct validity, Newnam et al. (2011) acknowledged that the scale does not incorporate a broad range of concepts that are also associated with work related driving such as mobile phone use (e.g., Lam, 2002; Salminen & Lahdeniemi, 2002), in-vehicle technology systems (Wikman, Nieminen, & Summala, 1998) and eating and drinking (Jenness, Lattanzio, O'Toole, & Taylor., 2002). In addition, although the instrument appears to possess good criterion validity with the Driver Behaviour Questionnaire, further research is required utilising the Occupational Driver Behaviour Questionnaire to determine the ability of the instrument to accurately identify risky drivers and predict crash involvement and traffic violations.

In spite of these limitation, the authors suggest that the instrument can be useful within the work related driving context as a diagnostic tool, providing a means

of identifying behaviours to be targeted by interventions (Newnam et al., 2011). However, this research undertaken within the Australian context further highlights the need for future research in the development and application of self-report measures. In particular, Newnam et al (2011) state that further research is required to better understand the complexities associated with work related driving and the antecedents and outcomes of occupational driver behaviour.

3.7 WHAT SHOULD A WORK RELATED DRIVING RISK ASSESSMENT MEASURE IDEALLY LOOK LIKE?

An overall objective of this thesis is to ultimately contribute to improving work related road safety within the Australian light vehicle fleet context, through the development of a work driving risk assessment measure. The development of such a measure will assist organisations in fulfilling their legislative obligations along with providing a tool to facilitate organisational risk assessment and management of work related driving. While organisations are seeking improved methods and tools to assess and subsequently manage work related driving risk, there are a number of practical issues that require consideration.

3.7.1 Practical industry considerations

Firstly, any tool developed to assess work driving risk must be capable of being easily administered within an organisational setting. Within any organisational setting, work drivers are likely to consist of a wide range of individuals with various levels of intellectual capabilities and individual differences. In addition, fleet operations within organisational settings are likely to encompass employees performing many different jobs and tasks as part of their role. Furthermore, although driving may be a requirement of their job it may not be viewed as a key component of their role and as such, any administration of a work driving risk assessment measure may be seen as a distraction to their day to day task and workload. Consequently, any work driving risk assessment measure developed should ideally be capable of being easily administered and be reasonably non-intrusive in terms of the day to day functions of staff.

Secondly, although crashes do have an economic cost to an organisation's overall budget, a work driving risk assessment tool will need to be relatively inexpensive for the organisation to administer. Although administration of a work

driving risk assessment measure may be a crucial step in improving work driving safety, weighing up the costs of assessment against other organisational purchase requirements will always be a consideration.

Thirdly, the administration of a work driving risk assessment measure would also ideally need to be relatively time efficient, not repetitive and subsequently concise. Although, the research outlined within Chapter 2 identified a wide range of potential determinants of work related injury and crashes, the inclusion of a range of items assessing all of these factors may make an assessment tool unwieldy. In addition, although from a research perspective many of the items for inclusion may contain subtle differences, participants may consider many items repetitious. If a work driving risk assessment measure is lengthy, participants would also require an inordinate amount of time to complete such a tool and organisations will be loath to allocate extensive timeframes for completion. Consequently, although as researchers we would like a measure to incorporate as many relevant factors as possible relating to work driving, a key consideration in a work driving risk assessment measure will be in its brevity to ensure it can be completed within a short acceptable time frame.

Fourthly, any work driving risk assessment measure developed and utilised within an organisational setting must be seen as relevant by not only organisational management but also drivers required to complete the measure. Therefore, consideration must be given to ensuring that items incorporated within the measure appear relevant to the issues currently experienced by drivers within the work setting. In addition, from an organisational perspective, items must be representative of the wide range of factors and issues (e.g. environmental, personal, organisational) contributing to unsafe driving outcomes.

Finally, the results obtained from the use of such a tool must be viewed as valid and applicable within an organisational setting. Although previous research has utilised various measures reflecting risky driving behaviour as outcome measures (Eg. Wills et al, 2009; Newnam & Watson, 2010; Newnam & Von Schuckmann, 2011), ultimately, organisations are interested in reducing the frequency of their vehicle fleet crashes and traffic infringements along with fatalities, injuries, and workers compensation and insurance claims. Consequently, any such work driving risk measurement tool, in order to be considered and adopted for use by industry,

will need to predict outcome variables such as crashes and traffic offences in order to be able to prevent them.

3.7.2 Research Considerations

The development of a work driving risk assessment measure will not only require addressing the practical industry issues outlined above, but will also need to consider a number of research related issues. Given the previous use and validation of self-report assessment tools across a variety of settings, including road safety outlined earlier within this chapter, the use of a self-report measurement tool may provide an ideal solution for addressing many of the practical industry issues, while still meeting the requirements of being a robust tool for research purposes. The key research requirements which will still need to be met are discussed below.

Firstly, similar to industry concerns, a work driving risk assessment measure from a research perspective would need to be easy to administer and cost efficient. As highlighted earlier in this chapter, self-report measures appear to offer an ideal solution for addressing administration and cost issues and consequently are often utilised in research for those very reasons (af Wåhlberg , 2009).

Secondly, given the complexities associated with potential factors that influence work related driving, self-report data provides an advantage over other sources of data (such as crash databases) by obtaining information that is more comprehensive. For example, self-report data offers an advantage of exploring and understanding underlying factors that are not normally captured within crash databases. In addition, a self-report measure offers an opportunity for inclusion of many of these factors and the evaluation of their association with risky driving outcomes such as crashes and offences.

Thirdly, self-report measures offer an ideal solution to ensuring confidentiality and anonymity within work vehicle fleet environments, which may encourage drivers participating in the research to provide information that in other circumstances they may be reluctant to do so. For instance, drivers may be reluctant to provide information in the event of a real crash within a fleet setting for fear of retribution. In contrast, the use of a self-report measure, ensuring anonymity and confidentiality, may actually encourage drivers to provide this information. Furthermore, in regard to traffic offences, a self-report measure offers the opportunity for drivers to indicate

the frequency of traffic infringements incurred outside of the work setting, which would otherwise not be able to be obtained.

Fourthly, a further research consideration is that previous research has consistently struggled to develop an appropriate self-report measure capable of accurately predicting crashes and traffic offences, especially a measure applicable to the Australian light vehicle fleet context. As highlighted earlier within this chapter, many self-report measures currently utilised in other research don't include items and terminology that may be particularly relevant to the Australian vehicle fleet setting. As such, there appears to be a distinct gap in the research and a consideration in the development of a new self-report measure is to incorporate items particularly relevant to the Australian setting, especially in regards to terminology and encompassing the wide variety of factors influencing work driving.

Fifthly, decisions would need to be made during the development of the measure regarding which items and concepts are to be included within the tool. Initially, the development of a self-report work related driving risk assessment measure could be informed by previously utilised and popular measurement scales. Given the widespread use of the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) items from these scales could be initially incorporated within a new measure. In addition, incorporating some of these items in the measure will enable the research to ascertain their ability to accurately predict outcomes required by industry, such as crashes and offences. However, the above mentioned scales do not incorporate many of the potential determinants of crashes and injury conceptualised by Stuckey et al., (2007), and consequently, development of a more comprehensive work related driving risk assessment measure will need to incorporate items and concepts consistent with the layers identified within the Occupational Light Vehicle Use Systems Model.

Sixthly, other measures developed for use within the work driving settings such as the Fleet Driver Risk Index (Dorn & Gandolfi, 2008); the Bus Driver Risk Index (Dorn, et al., 2010) and the Occupational Driver Behaviour Questionnaire (Newnam et al., 2011) are also worthy of consideration for informing the development of a new self-report work driving risk assessment measure. However, it should be noted that the initial studies included within this program of research were undertaken prior to,

or coincided with, the publication of each of the studies associated with the above measures. Consequently, when the early stages of this program of research were being undertaken to test previously developed self-report measures, the Fleet Driver Risk Index (Dorn & Gandolfi, 2008); the Bus Driver Risk Index (Dorn, et al., 2010) and the Occupational Driver Behaviour Questionnaire (Newnam et al., 2011) were in their developmental infancy (or not even developed) and therefore not available for other research.

In summary, the development of a work related road safety risk assessment measure requires careful consideration of the practical industry related and research related issues outlined within this section if such a measure is to be accepted and utilised within the work driving safety setting. Consequently, the work related road safety risk assessment measure being developed within this research program will be self-report in nature, containing items from previously utilised measures as well as additional items representing other factors known to influence work driving crash and offence involvement. These additional items will be designed to represent potential determinants of injury and crashes as conceptualised within the layers of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). However, due to reasons of parsimony in accordance with industry considerations, the tool may not be able to incorporate items encompassing all potential determinants within the Occupational Light Vehicle Use Systems Model.

In light of the information covered in this section, it is now considered timely to revisit the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) and provide an outline of the manner in which the model guided the research undertaken within this research program and can assist in answering the research questions outlined in section 2.13.

3.8 OCCUPATIONAL LIGHT VEHICLE USE SYSTEMS MODEL AS A GUIDING FRAMEWORK IN THE DEVELOPMENT OF THE RESEARCH PROGRAM

As discussed in section 2.6, the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) is specifically applicable to the work driving setting and conceptualises a multilayered framework incorporating a wide range of potential determinants to injury and crashes (Refer Figure 2.1). The model incorporates factors of potential influence at five distinct levels including; the individual level

conceptualised as the driver and passenger; the immediate physical environment level which constitutes the vehicle; the external work environment being the road; the organisational environment which incorporates a range of potential factors including work arrangements and demands, management systems and processes and incident management; and the policy environment, external influences at the local national and international level which includes relevant legislation and policy. Consequently, the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) acknowledges the systemic nature of the work driving context and thus provides an ideal framework to guide this research program. In particular, the model provides assistance in the conceptualisation of items for consideration in the development of a self-report risk assessment measure applicable to the work related light vehicle driving setting.

Previous research highlighted in section 3.5 discussed three self-report measures commonly utilised within the road safety setting; the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005). While previous research has utilised these measures within a variety of driving safety research settings, there was little evidence in regards to their use and applicability within the Australian work driving context. In addition, it remains unclear as to the relationship of these measures to risky work driving behaviour outcomes such as crashes and traffic offences.

It is acknowledged that many of the concepts incorporated within the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) are consistent with a range of potential determinants conceptualised by Stuckey et al., (2007). For example, the Driver Behaviour Questionnaire (Reason et al., 1990) incorporates items designed to represent behaviours (Eg. *Errors, Aggressive Violations*) consistent with the driver and passenger level of potential influences within the Occupational Light Vehicle Use Systems Model conceptualised by Stuckey et al., (2007).

The Driver Attitude Questionnaire (Parker et al., 1996), although containing attitude items in contrast to behaviours, also incorporates concepts relating to major issues and potential influences on work driving such as drink driving, risky

overtaking, speeding and following other vehicles closely. These types of items are also consistent with potential influences associated with the first and fifth levels within the Occupational Light Vehicle Use Systems Model conceptualised by Stuckey et al., (2007).

The Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) measures organisational related concepts such as employee perceptions towards fleet safety rules, communication and support, work pressures, adequacy of fleet safety procedures and management commitment to work driving safety. Consequently, concepts associated with the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) are consistent with potential determinants outlined in the organisational level of potential influences within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007).

Therefore, determining the ability of the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) to predict crashes and offences within the work driving setting will seek to provide an answer to the first research question. In addition, results obtained from assessing these measures could then not only determine their suitability for inclusion in the future development of a self-report work driving risk assessment measure, but also offer an opportunity to investigate a range of potential determinants to risky driving outcomes included within other measures and consistent with Stuckey et al., (2007) Occupational Light Vehicle Use Systems Model.

It is acknowledged that the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) also incorporates additional potential determinants of crashes and injury not contained within previously designed measures. Therefore the additional potential determinants highlighted within the model, provide insight particularly in answering the second, third and fourth research questions in this program of research.

In regards to the second research question, although the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) encompasses a range of factors expected to have a major influence on driving behaviour, it remains unclear as to which are the predominant factors influencing work driving behaviour from the perspective of the driver. It also remains unclear as to whether there are any factors

of influence to work driving behaviour not encapsulated within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). Therefore seeking drivers' perceptions as to what they believe influences their driving behaviour will assist in establishing which predominant factors incorporated within the model should be included within a work driving risk assessment measure. Use of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) as a guiding framework for item development will assist in the consideration of factors identified from drivers' perceptions not included within the model to be considered.

Given the work driving and organisational context, items incorporated within a work driving risk assessment measure encompassing factors such as those conceptualised by Stuckey et al., (2007) could be expected to be associated with unsafe driving outcomes such as crashes and offences. For example, factors within the driver and passenger levels of influence such as driving exposure and driving behaviours, along with factors consistent with the immediate environment (vehicle) and organisational environment (work arrangements, work demands, mobile phone demands, etc.) are potential indicators of risky driving behaviour. Therefore, the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) also provides assistance in the development of the research program in regard to the third and fourth research questions by conceptualising various environmental, organisational and driver related factors which need to be considered for inclusion in a work driving risk assessment measure.

3.9 METHODOLOGICAL ISSUES RELEVANT TO OPERATIONALISING THE PROGRAM OF RESEARCH

There are always a number of methodological issues for consideration associated with any research that is undertaken. One methodological issue within this program of research relates to the type of data used to operationalise outcome measures of risky driving such as crashes. Firstly, insurance data or incident data recorded by organisations were considered. However the use of "real world" incident data collected by the organisations operating the fleet or the insurance provider is somewhat limited. As has been highlighted previously in Chapter Two of this thesis, work related road safety and subsequent organisational management of risks associated with driving have been primarily addressed in a reactive manner after the event, and focussed on asset management (Stuckey et al., 2010; Davey et al., 2008;

Wishart et al., 2004; Wishart & Davey, 2004). As such, within almost all organisational settings, data relating to work related vehicle incidents focus on the asset rather than contributing factors or details relating to the crash. Consequently, crashes reflected in data such as insurance records lack comprehensiveness and in many cases feature extensive missing data (Wishart, Rowland, Freeman, & Davey, 2011). As a result, any organisational incident data that does happen to exist is substantially unreliable for use as dependant variables or outcome measures, in relation to work related risky driving behaviour.

A further concern associated with the use of organisational crash data relates to privacy and confidentiality. Within the organisational context, each participating organisation is required to protect the privacy of employees in accordance with the Privacy Act (1988). Consequently, organisations can only provide fleet crash records to researchers and other parties after de-identifying the data, which makes it impossible to link crashes specifically to particular drivers or their responses to questionnaires.

In addition to crashes, this thesis was also interested in traffic offence outcomes. Unfortunately, again due to the above mentioned privacy issues, actual traffic offence records were also not able to be provided by the organisations involved.

A further data source considered for use as outcome measures within this research program was vehicle data obtained through in-vehicle monitoring systems. However, there were a number of complexities associated with this approach which relate to confidentiality, ethical and legal considerations for the drivers and participating organisations. Organisations approached to participate in each of the stages of research were reluctant to even consider supplying data or participating in research that may result in legal proceedings against the organisation or the employees. For example, if any in-vehicle monitoring systems provided data confirming illegal activities of drivers (such as speeding) then the organisation's management and drivers potentially could be subject to legal proceedings if the data was required for use as evidence. Consequently, organisational management within organisations approached to participate, expressed extreme reluctance to partake in any program of research incorporating this potential business or legal risk.

In addition, in-vehicle monitoring data also suffers from limitations associated with validity, measuring events such as harsh braking or swerving as measured by G force without consideration of the specific context of the driving event. For example, harsh braking events, although potentially considered as a negative context and examples of vehicle abuse or harsh driving, may actually be as a consequence of avoiding an incident such as another vehicle, pedestrian or animals in regional areas. Consequently, although in vehicle monitoring offers benefits for research and industry application, there is a need for in vehicle technology to progress to a stage whereby safe and unsafe driving can clearly be defined, articulated, identified and measured. Therefore, the future use of in vehicle monitoring data within industry settings will require extensive research to investigate and determine these parameters. However, this research is outside the scope of the current research program.

The research undertaken within this current thesis is therefore reliant on data and outcome measures such as crashes and offences that are self-report in nature. While methodologically this is not ideal, it does provide an indicator of driving behaviour and has been extensively utilised in previous driver behaviour research (refer af Wåhlberg , 2009).

A second methodological issue within this program of research that requires acknowledgement is the different samples utilised across the various studies. The current program of research undertaken within this doctoral dissertation also forms part of a greater program of work related road safety research involving the PhD candidate. Consequently, the research involved a number of industry partners related to the broader research work context. Therefore, across the seven years of this thesis, different industry partner networks were involved in the research program across various stages simply due to their availability and agreement to participate. In addition, the research being undertaken requires a high level of industry applicability if any results achieved are to provide benefits to improve work related road safety risk assessment procedures. Accordingly, the studies undertaken require industry involvement and any surveys administered require samples to be obtained using current drivers that drive for work. Consequently, all samples obtained and administration of measurement tools relied on the cooperation of industry, management and their employees. Hence, the research program was undertaken in a

real world work and industry setting involving current work drivers thought to represent the broader spectrum of light vehicle fleet operations within Australian settings. As a result, although the sample sizes are all quite large and sufficient for statistical purposes, the studies utilise different samples and sample sizes which may offer potential limitations. However, any limitations associated with this methodological issue will be discussed in the final chapter of this dissertation.

3.10 CHAPTER SUMMARY

This chapter has provided some insight into what a work driving risk assessment measure should look like. Initially it discussed some of the difficulties associated with predicting human behaviour and briefly reviewed the philosophy of the actuarial approach incorporating screening and assessment. Given the vast array and complexities associated with factors of potential influence to work driving safety, a rationale was provided for the development of a self-report work driving risk assessment measure. Despite ongoing concerns about the use of self-report data, this chapter also reinforced the value particularly to organisational fleets of a self-report work driving risk assessment measure. This chapter also highlighted the shortcomings associated with recent fleet assessment tools (e.g., Newman et al., 2011) which only confirms that more research needs to be completed in the area. A number of practical industry and research considerations associated with assessment instruments were also highlighted which attests to the difficulties in developing a comprehensive and valid measure that is also easily administered and conducive to industry personnel and settings. This chapter has also provided a foundation from which to progress and inform the development of a work driving risk assessment measure applicable to vehicle fleet settings and the manner in which the Occupational Light Vehicle Use Systems Model provides a guiding framework for the research. Finally, this chapter has highlighted a number of methodological issues associated with the operationalisation of this program of research.

As previously mentioned in Chapter One, this thesis is undertaken by publication consisting of a number of peer reviewed publications. The following chapter provides an outline of the approach to which each publication is structured within the thesis and the manner in which each publication addresses the aim and objectives of the research program.

Chapter 4: Structure of the Research Program and Related Publications

4.1 INTRODUCTORY COMMENTS

Earlier sections of this thesis have identified a number of gaps in work related road safety *practice* in regards to difficulties for organisations to identify and subsequently manage risk in organisational vehicle fleet settings. In addition, a number of gaps in the *research* have also been highlighted, especially in regard to the difficulties and issues associated with the development and use of self-report risk assessment measures.

Firstly, Chapter Two outlined the issue of work related road safety and risk management and highlighted the overrepresentation of injury and crashes associated with driving for work. The types of crashes involving vehicles driven for work purposes were also highlighted and some of the unique aspects of crashes involving work vehicles were discussed. It was also identified that there is a need to improve work related road safety, particularly within the Australian organisational fleet context. However, in order to embark upon improving work driving safety, potential influences to work driving and unsafe work outcomes must first be identified.

To provide a guiding framework conceptualising the vast array of potential contributors to work related crashes across various levels of influence associated with the driver, external and organisational environments, the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) was introduced. This model which was conceptualised as specifically relevant to the work driving setting was then utilised as a framework to provide structure for discussing previous research and relevant literature. In regards to potential determinants of crashes and injury associated (in particular) with the driver, previous research has identified a range of influences to driving behaviour relating to not only personal factors such as age and gender but also driver related activities such as speeding, aggression, and alcohol and drug use. While compelling evidence attests to the contribution of factors such as age, gender and driving exposure to increased crash risk, a number of gaps in the research were also identified in regards to other driver related factors. For

example, previous research outlined in section 2.6.3 indicates mixed results within fleet settings in regards to speeding associated with work vehicles and crash outcomes.

Chapter Two also highlighted research associated with external factors of potential influence associated with the immediate physical environment such as the vehicle and the external environment of the road. While there is evidence attesting to the influence of factors associated with the vehicle and road environment to work driving outcomes, many of the decisions and activities associated with addressing the issues linked with these factors are out of the immediate control of the work driver. However, one activity in particular which relates to the employee conducting pre start maintenance checks is within the direct control of the work vehicle driver and consequently can be viewed as a process of risk mitigation.

Chapter Two also highlighted a wide range of organisational factors which have the potential to influence work driving behaviours and subsequently contribute to crashes and injury within a work driving setting. Within this chapter, a number of gaps in both research and practice were identified relating to risk management and incident reporting and incident management. In particular, it was highlighted that although these processes are central to improving work driving safety, there is a distinct lack of tools developed specific to the work driving setting to utilise as lead indicators and identifiers of work driving risk. Consequently, there is a need within the work driving setting for the development of a comprehensive risk assessment tool.

The research relating to other influences within the organisational environment outlined within Chapter Two, also identified the impact on work driving safety associated with work task design, mobile phone use requirements, fatigue management and organisational safety culture and climate. However, in regard to work driving risk assessment, the research remains unclear as to the strength of these influences in regards to predicting risky driving behaviour outcomes such as crashes and traffic offences. Consequently, although these influences should be included within the development of a work driving risk assessment measure, there is a gap in the research to further investigate the contribution of these influences to unsafe work driving outcomes.

Chapter Two also considered the relevance of various legislation associated with policy environment and public policy level identified within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). It was identified that although legislation mandates the need to manage and mitigate work driving risk within an organisational setting, a gap exists within the research and industry practice in the development and provision of research informed measures to identify risk and subsequently assist industry in achieving these requirements.

Chapter Three provided insight into what a work driving risk assessment measure could look like. This chapter initially reviewed literature relating to some of the difficulties of predicting human behaviour across a variety of research and psychological settings. It argued that similar to other domains such as clinical, forensic and legal settings, a work driving risk assessment measure should be self-report in nature. That chapter also discussed some potential industry and research considerations associated with the development and implementation of a work driving risk assessment measure.

Chapter Three also reviewed the current research associated with three self-report measures; the Driver Behaviour Questionnaire (Reason et al., 1990); the Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) which have been previously used within the road safety and work research context. The results of previous research associated with these measures suggest that while each measure has distinct merit within driving safety research, there appears to be a gap in the research establishing the merit of these instruments within the Australian work related driving context. As a result, further research is required to determine the suitability of these measures to the Australian work driving context and, in particular, identification of work driving risk. Consequently, there is a gap in the current research and practical application of these measures within the Australian work driving setting in regards to their ability to predict work driving risk outcomes.

Chapter Three also highlighted the manner in which the Occupational Light Vehicle Use Systems Model (Stuckey et al, 2007) assists in the development and guidance of this program of research. Chapter Three, concluded by discussing a number of methodological issues relevant to the operationalisation of the program of research.

This thesis, in accordance with Queensland University of Technology requirements, is undertaken by publication and consists of five peer reviewed and published papers. Accordingly, this chapter (Chapter Four) is intended to provide an overview of the structure of the research program and the manner in which each publication contributes to the research aims within this thesis.

4.2 STRUCTURE OF THE RESEARCH PROGRAM AND CONTRIBUTION OF PAPERS TO THE RESEARCH AIMS

The overall structure of the research program and the contribution of papers to the research aim and objectives are discussed below. Table 4.1 is also provided to assist in illustrating the manner in which each paper contributes to the overall aim and objectives of the research.

4.2.1 Stage One

Although the primary aim of this research program is to contribute to the safety of work related drivers by developing and testing a new driver risk measurement tool for use by organisations, an initial step is to explore the capability of previously utilised measures to predict risky drivers. Suffice to say, that if previously developed self-report measures demonstrate a good capacity to identify risky drivers then any future development of a self-report occupational driving risk assessment measurement tool could build upon and incorporate these previously utilised scales. Therefore, stage one of this research is undertaken specifically to address the first objective of the research program namely to:

1. Investigate the ability of previously designed self-report measurement tools to predict work related driving risk within Australian vehicle fleet settings.

In order to address the first objective, the initial phase of this research incorporated two studies which assessed the ability of previously developed self-report measurement tools to assess their suitability and applicability in predicting work related driving risk. More specifically, these studies would also seek to provide answers to the first research question by determining if these measures can predict self-reported crashes within the Australian work related driving setting. Therefore, two studies were undertaken in this initial stage whereby these previously designed

self-report measurement tools were administered to samples of drivers driving for work within Australian organisations.

The first paper (Chapter Five) reports on a study utilising three previously designed measures Driver Behaviour Questionnaire, Driver Attitude Questionnaire and the Safety Climate Scale Modified for Drivers, to a large sample (N = 4195) of fleet drivers within Australia to determine the suitability of each of these measures to predict risky driving behaviour.

The second paper (Chapter Six) reports on a study utilising the traditional Driver Behaviour Questionnaire to a sample (N = 443) of Australian drivers within an organisation in the insurance industry. Additionally in this study, the questionnaire administered also incorporated a number of additional items designed to represent various contemporary issues associated with driving for work purposes within the Australian fleet context. These items were included in order to explore other organisational factors, not incorporated within the traditional Driver Behaviour Questionnaire, that were hypothesised to impact on work related driving. This was undertaken to investigate their combined influence on unsafe driver behaviour outcomes particularly within the organisational driving context.

4.2.2 Stage Two

Stage Two contains the third published paper designed to address the second objective of the research program:

2. Investigate drivers' perceptions regarding what influences their driving behaviour within the organisational driving context.

This publication (Chapter Seven) reports on a qualitative study undertaken and designed as an open ended approach, obtaining the opinions from a sample of Australian drivers (N = 217), who drive as a part of their work role, regarding what are the predominant factors that they believe influence their work driving. The results of this study will not only provide answers in regard to the second research question, but also identify additional factors to those highlighted in Chapter Two, that influence work related drivers in the Australian context. In addition, the results obtained from this open ended approach will provide further opportunity to inform the development of items for inclusion in a new work driving risk assessment scale.

Table 4.1: Overview of the research process and manuscripts placement within the process

Primary Aim

Contribute to the safety of work related drivers by developing and testing a new driver risk measurement tool for use by organisations.

Method

Published papers 1, 2, 3, 4, 5.

Stage 1

Objective 1

Investigate the ability of previously designed self-report measurement tools to predict work related driving risk within Australian vehicle fleet settings;

Research Question

1. Can previously designed self-report measures predict self-reported crashes and offences within Australian work related driving settings?

Stage 2

Objective 2

Investigate drivers' perceptions regarding what influences their driving behaviour within the organisational driving context;

Research Question

2. What are the predominant factors that drivers believe influence driving behaviour within work related driving settings?

Method

Published Paper 3 (Chapter 7) - Identifying influences of driving behaviour: Could the Australian work driving setting be unique?

Stage 3

Objective 3

Identify current and emerging issues that impact upon the development of self-report driving risk assessment measures within the work driving setting;

Method

Published Paper 4 (Chapter 8) - Developing risk assessment tools for fleet settings where to from here?

Objective 4

Investigate the ability of a newly devised self-report work driving risk assessment measure to predict crashes and offences within the light vehicle fleet context;

Research Questions

3. Can environmental, organisational and driver related factors that influence work related driving predict crashes and offences within a fleet environment?
4. Can a newly devised work driving risk assessment measure identify risky drivers by predicting crashes and traffic offences within the Australian work driving context?

Method

Published Paper 5 (Chapter 9) - When non significance maybe significant lessons learned from a study into the development implementation and evaluation of a risk assessment tool for fleet settings

Chapter 10 - Conclusion, synthesis of results in regard to aim and objectives, limitations of current study, future directions

4.2.3 Stage Three

Stage Three incorporates two publications designed to address the third and fourth objectives of the research program:

3. Identify current and emerging issues that impact upon the development of self-report driving risk assessment measures within the work driving setting.
4. Investigate the ability of a newly devised work driving risk assessment measure to predict crashes and offences within the light vehicle fleet context.

The fourth publication (Chapter Eight) was incorporated into the program of research in response to the increased development and activities associated with work related road safety and risk assessment globally since the commencement of the current thesis. When the research program outlined within this thesis commenced, research in the work related road safety area and risk assessment measure development was somewhat limited. However, due to increased interest and potential opportunities involving researchers, organisations and road safety stakeholders, work in this area over the life of the current research program became invigorated and increased substantially. This contextual paper (Chapter Eight), upon outlining various limitations of self-report work driving risk measurement tools, provides the foundation for further driving risk assessment measurement development. The paper provides recognition and acknowledgement that item development must incorporate a stronger focus toward developing and including items reflecting organisational related issues and influences, as opposed to the primarily driver related issues and influences focussed on in previous measures. Therefore, Chapter Eight elaborates on the previous publications while adding further enhancement and consideration relating to the fourth objective of this program of research.

The fifth publication (Chapter Nine) reports on the administration and results of a newly devised 38 item contemporary occupational driving risk assessment scale to a sample of 546 work drivers from organisations within Queensland, Australia. The main objective of this study was to determine the effectiveness of this instrument to predict high risk work related drivers defined as those drivers involved in a crash. The results obtained would thus provide evidence in answering the third research question. The new measure also incorporated items similar to previously developed self-report measures reflecting concepts such as speeding and aggression along with other behavioural based items reflecting concepts such as time pressure, distraction, casualness, self-awareness, vehicle maintenance, fatigue and minor damage. Therefore, the inclusion of a range of additional items representing various environmental, organisational and driver related factors and the subsequent results obtained from this study, also addresses the last research question by determining if these factors can predict crashes and traffic offences in the Australian setting. This study discusses the implications of the results in relation to this thesis and future research directions in risk assessment within the organisational driving context.

Finally, each of the five published papers incorporated into the overall research program, in conjunction with the final chapter in this thesis which synthesises the results reported within the publications, contribute to the primary aim of this thesis which is to:

Contribute to the safety of work drivers by developing and testing a new work driver risk measurement tool for use by organisations.

4.3 CHAPTER SUMMARY

Chapter Four has provided an overview of each of the publications and the studies within them, incorporated within this thesis and the manner in which each publication addresses the particular aim, objectives and research questions in this research program. Chapter's Five through to Nine comprise each of these publications. It should be reiterated that in accordance with Queensland University of Technology thesis by publication requirements, the reference lists associated with each publication have been removed and collated into the reference list provided for the overall thesis. Chapter Ten presented as the final chapter, comprises a synthesis of the overall research findings, the contribution of each paper to the particular aims

of the research program, theoretical and methodological implications associated with the research, limitations of the research, and suggestions for future research directions in regard to work related road safety and risk assessment measure development.

Chapter 5: Predicting High Risk Behaviours in a Fleet Setting: Implications and Difficulties Utilising Behaviour Measurement Tools

5.1 INTRODUCTORY COMMENTS

As outlined in section 1.9 the following paper is presented in its published form. The research incorporated within the paper was primarily designed to address the first objective of this thesis by investigating the suitability and applicability of three previously designed and popular self-report measures for use in assessing work related driving risk. The three measures utilised in this paper are the Driver Behaviour Questionnaire (Reason et al., 1990), Driver Attitude Questionnaire (Parker et al., 1995), and Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005), although as outlined in the following paper, some minor wording modifications were undertaken to ensure that the items were applicable to Australian work driving conditions. For example, wording in the Safety Climate Questionnaire incorporated reference to the term "work driving" and items within the Driver Behaviour Questionnaire indicating directions such as turning "right" or "left" were removed.

As previously discussed, the Driver Behaviour Questionnaire was originally developed by Reason and colleagues (1990) and primarily focussed on two factors associated with driving namely, errors and violations. Subsequent research has modified the original version by incorporating additional items, such that the current Driver Behaviour Questionnaire is designed to measure driver behaviour constructs associated with aggression, legislative breaches and common driving mistakes (Lawton et al, 1997). The Driver Attitude Questionnaire is designed to measure driver attitude levels toward typical issues associated with road safety (Parker et al., 1996). These are concepts such as attitudes toward alcohol and driving, close following of vehicles, risky overtaking, and speeding. An example of an item designed to measure a driver's attitude towards alcohol and driving is "Some people can drive perfectly safely after drinking three or more pots of beer in an hour". A

typical example of the type of item involved in the concept of close following is "Close following isn't really a serious road safety problem". The construct of risky overtaking incorporates items such as "I think it is ok to overtake in risky circumstances as long as you drive within your own capabilities" while the concept measuring attitude toward speeding contains items such as "The main aim of speeding fines is revenue raising" (Parker et al., 1996).

The Safety Climate Questionnaire Modified for Drivers used within this study was adapted from the scale developed by Glendon and Stanton (2000) and later modified by Wills et al., (2005) and used in a work related driving setting by Wills et al., (2006). It incorporates items designed to measure employee perceptions, in regard to constructs such as Fleet Safety Rules, Communication and Support, Work Pressures, Adequacy of Work Procedures, and Management Commitment. Fleet Safety Rules is the concept that relates to employee perceptions regarding the ease and suitability of organisational rules associated with safe motor vehicle use for work practices. For example, "Safety rules relating to the use of motor vehicles can be followed without conflicting with work practices" is an item in this sub scale. Communication and Support items reflect employee perceptions regarding whether safe rules, regulations and guidelines within the organisation are effectively communicated to employees and incorporates items such as "Safety policies relating to the use of motor vehicles are effectively communicated to workers". The Work Pressure sub scale is designed to assess employee perceptions that relate to whether they believe that driving safety is compromised due to the pressures associated with work task performance or workloads. For example, "There is sufficient time to enable employees to drive safely for work" is an item included in this subscale. Adequacy of Work Procedures is a subscale regarding employee perceptions that work procedures relating to motor vehicle use are comprehensive and adequate to ensure safety. For example, "Safety procedures relating to the use of motor vehicles are complete and comprehensive". The final concept in the Safety Climate Questionnaire comprises employee perceptions of whether management are committed to work related road safety and consists of items such as "Driver safety is central to management's values and philosophies".

As outlined in Chapter Three, previous research has primarily adopted the use of these measures in general road safety contexts and research using these measures

within Australian professional driver and fleet settings has been limited. An exception, in part, to this is the Safety Climate Questionnaire, which was developed for use within work settings (Glendon & Litherland, 2001) and subsequently modified for use in work driving settings (Wills et al., 2005; Wills et al., 2006). Therefore, the current research endeavours to test the suitability of these measures in a large sample of work drivers to accurately predict crash involvement while driving for work. The outcome measure of crash involvement was chosen to be consistent with risk management processes and model frameworks whereby the consequence of poor risk management processes is ultimately incidents (Reese, 2001) or, in the case of work related driving, crashes. As previously discussed in Chapter Two, the management of risk within the road safety context and particularly the workplace, highlights the complexities associated with interactions between people, managerial processes and operational requirements (Stuckey et al., 2007).

In addition, the use of these three previously developed measures will also facilitate exploring issues consistent with some of the multiple levels of influence as proposed in the Occupational Light Vehicle Use Systems Model by Stuckey et al., (2007). For instance, many of the items contained within the Driver Behaviour Questionnaire (Reason et al., 1990) utilised within the study in the proceeding paper are consistent with the theoretical framework outlined within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). For example, items contained within the constructs of aggression and errors are consistent with the potential determinants contained within first level of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) relating specifically to drivers and passengers. The construct of Highway Code Violations within the Driver Behaviour Questionnaire (Reason et al., 1990) incorporate items also consistent with behaviours at the first level of the Occupational Light Vehicle Use Systems Model but are also impacted on by developments in policy, environment, and external influences relating to driving behaviour legislation, incorporated into the fifth level of the model (Stuckey et al., 2007).

Items within the Driver Attitude Questionnaire (Parker et al., 1996) are designed to provide an indicator of attitudes and although not specifically measuring driver behaviour, do contain factors incorporating items that encompass influences on driver behaviour consistent with Stuckey et al.' s, (2007) Occupational Light

Vehicle Use Systems Model. For example, attitudes toward alcohol consumption and aggression are encompassed within the driver and passenger level, other attitudinal measures such as speeding, and risky overtaking can be considered to be encompassed within immediate physical environment and organisational environments.

The Safety Climate Questionnaire was included to not only address the first objective of this research program, but also to examine a previously utilised measurement tool that incorporates items particularly relating to the third and fourth levels within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). These levels are associated with influences on driver behaviour that relate specifically to the work organisational environment and are often outside the direct control of the employee driver. This is particularly the case for those factors assessed through work design and demands subscales.

In addition, investigating concepts such as driver attitudes and safety climate extends the research direction in the work related driving field, beyond primarily focussing on individual driver behaviour such as errors, violations and aggression. Consequently, there is an opportunity to further explore not only errors, violations and aggression but also organisational safety climate in conjunction with driver attitudes and potential links with unsafe driving behaviour.

The results of this study will therefore contribute to answering the first research question:

Can previously designed self-report measures predict self-reported crashes and offences within Australian work related driving settings?

The research results associated with utilising these previously developed measures within the context of a large fleet environment would establish whether the measures are applicable to the Australian fleet setting and effective in predicting self-reported crashes and traffic offences. If the results associated with these measures are encouraging, then items within the Driver Behaviour Questionnaire, Driver Attitude Questionnaire and Safety Climate Questionnaire Modified for Drivers could be incorporated within a future work driving risk assessment measure.

Therefore in summary, the study described in the next sections of this chapter reports on the administration of the Driver Behaviour Questionnaire (Reason et al.,

1990), Driver Attitude Questionnaire (Parker et al., 1995), and Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005), to a large sample of fleet drivers. The work drivers participating in this research (N = 4195) were employees of a large Australian based organisation that operates a light vehicle fleet of more than 12 000 vehicles across all state jurisdictions within Australia.

5.2 AUTHOR STATEMENT OF CONTRIBUTION

In the case of this chapter presented as published, the authors listed below have certified that:

They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

There are no other authors of the publication according to these criteria;

potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and

They agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

Contributor	Statement of contribution
Dr James Freeman	Advised in all aspects of project conception, experimental design, data collection and analysis. Co authored manuscript.
Prof. Jeremy Davey	Advised in all aspects of project conception, experimental design, data collection and analysis. Co authored manuscript.
Darren Wishart	Involved in all aspects of project conception, industry negotiation, proposal, experimental design, data collection and analysis. Co authored manuscript.

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Dr. James Freeman Date: 18/11/2013

5.3 PAPER ONE (AS PUBLISHED)

Freeman, JE., Davey, JD., Wishart, DE. (2008). Predicting high risk behaviours in a fleet setting: Implications and difficulties utilising behaviour measurement tools. In L. Dorn, (Ed.), *Driver behaviour and training, Volume III* (pp. 175-187). England: Ashgate.

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http://www.ashgate.com/isbn/9780754672036

5.12 CHAPTER SUMMARY

In summary, this published paper sought to collectively investigate the utility of three previously designed measurement tools (including their subscales), in assessing work related driving risk within an Australian fleet setting, as determined

by the first aim of this thesis. More particularly, the study reported within this paper was undertaken to investigate if these three popular self-report measures can predict self-reported crashes within a work driving setting. Despite the low level of variance explained by the logistic regression model ($R^2 = 0.03$), the results did provide some evidence that in a work related driving environment exposure, determined by the number of kilometres travelled annually, is a key factor in contributing to potential risk (as measured by self-reported crashes). Consistent with the theoretical framework guiding this thesis, driving exposure is one of the initial potential determinants of injury and crashes incorporated within the first level of the Occupational Light Vehicle Use Systems Model relating to driver and passengers (Stuckey et al., 2007). In addition, the results indicating driving exposure being predictive of self-reported crashes offers some additional support for some of the potential determinants proposed by Stuckey and colleagues (2007).

It is also worth noting that in addition to kilometres travelled per year, self-reported driving errors and work pressure, contributed significantly to self-reported work related crashes (albeit only a p value of 0.10). Given that work driving occurs within an organisational setting and thus drivers are potentially influenced by organisational processes it was somewhat surprising that only these three factors predicted crashes. There are a number of implications of these results not only for industry but also for further research within this current thesis.

Firstly, the link between driving errors and crashes is consistent with the underlying premise associated with a safe system approach to general road safety. This premise suggests that within a road environment drivers will make mistakes and consequently safe system approaches acknowledge driver error and plan to minimise the impact of such an event (Australian Transport Council, 2011). In addition, driver error is also consistent with the first level of the Occupational Light Vehicle Use Systems Model relating to driver and passengers (Stuckey et al., 2007). However, the results obtained within this current study provide little insight into the particular contributing factors influencing drivers to make such errors. For example, although drivers indicated making errors which were represented by Driver Behaviour Questionnaire items such as failing to notice pedestrians or skidding while braking (Reason et al., 1990), the underlying reasons contributing to these types of mistakes remains unclear.

The finding indicating that work pressure appears to impact on driving safety is also consistent with the Occupational Light Vehicle Use Systems Model and, in particular, the fourth level associated with the organisational environment and work arrangements (Stuckey et al., 2007). The implications of these results would suggest that factors outside of the immediate control of the driver such as work arrangements influence their ability to drive safely for work.

In regard to this thesis, the results associated with the impact of driving errors and work pressure on crashes provides direction for the following study re-aligning the focus towards examining further organisationally related issues influencing driver behaviour in more depth. For instance, work related influences such as fatigue, multitasking and mobile phone use which were identified in Chapter 2, warrant more attention. In addition, the lack of association found between driver attitudes such as those encompassed within the Driver Attitude Questionnaire (Parker et al., 1995) and crashes further reinforced the need to focus on driver behaviour related issues, rather than attitudinal factors.

Overall, the results obtained within this study would indicate that the three previously designed measurement tools in their current form, whilst possibly suitable for various research activities, appear to possess only limited potential in identifying and assessing work related driving risk, as indicated by crash involvement within the context of work related driving in an Australian setting. It is apparent that there may be a range of other issues influencing work driver behaviour within the Australian context, which warrant further attention.

Chapter 6: A Study of Contemporary Modifications to the Manchester Driver Behaviour Questionnaire for Organisational Fleet Settings

6.1 INTRODUCTORY COMMENTS

The study reported in the previous chapter highlighted the limited ability for three commonly utilised measures to accurately predict work related crash involvement in a sample of Australian fleet drivers. However, the results did suggest that further exploration of potential organisationally related influences on work driving behaviour is required. These results appear to be consistent with suggestions made in earlier research within fleet settings conducted by Davey, Freeman and Wishart (2006) that a range of other factors such as fatigue, time pressure and multitasking (not assessed within current versions of the Driver Behaviour Questionnaire) may influence driver behaviour. Consequently, given that drivers in professional settings are at a greater risk of involvement in crashes (Newnam, Watson & Murray, 2004), an area of further interest was to investigate whether a modified version of the Driver Behaviour Questionnaire incorporating items reflecting these additional contextual factors could better predict self-reported crashes and offences within an Australian fleet context. The inclusion of these items was also consistent with concepts reflecting the organisational environment and work arrangements level of potential determinants of crashes outlined within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). In addition, these issues are also consistent with the inherent hazards associated with the driving task and the complexities of the worker environment and subsequent management of risk (Australian Transport Council, 2011; Reese, 2001).

Therefore, in accordance with the first objective of this research program, the published study contained within this chapter further explores factors influencing the behaviour of work drivers. More particularly, it investigates whether the original Driver Behaviour Questionnaire modified by inclusion of a number of additional items representative of the abovementioned work driver behavioural influences (e.g.,

fatigue, time pressure, and multitasking such as mobile phone use or eating while driving) can predict work related driving risk as measured by both self-reported crashes and traffic offences.

The sample utilised in this study consists of 443 employees that drive for work and are employed within an insurance company located within Australia.

6.2 AUTHOR STATEMENT OF CONTRIBUTION

In the case of this chapter presented as published, the authors listed below have certified that:

They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

There are no other authors of the publication according to these criteria;

potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and

They agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

Contributor	Statement of Contribution
Dr James Freeman	Guided all aspects of project conception, experimental design, data collection and analysis. Co authored manuscript
Prof Jeremy Davey	Guided all aspects of project conception, experimental design, data collection and analysis. Co authored manuscript
Darren Wishart	Involved in all aspects of project conception, industry negotiation, proposal, experimental design, data collection and analysis. Co authored manuscript.

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Dr James Freeman 18/11/2013

6.3 PAPER TWO

Freeman, JE., Davey, JD., Wishart, DE. (2008). A study of contemporary modifications to the Manchester Driver Behaviour Questionnaire for organisational fleet settings. In L. Dorn, (Ed.), *Driver behaviour and training, Volume III* (pp. 201-214). England: Ashgate.

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http://www.ashgate.com/isbn/9780754672036

6.10 CHAPTER SUMMARY

This study documented in this chapter, in conjunction with the previous study outlined in Chapter Five, contributes to addressing the first objective of the program of research by investigating the suitability and applicability of an adaptation of the predominant driving self-report measurement tools used to predict risky driving behaviour.

A number of additional items were included to augment the original Driver Behaviour Questionnaire with a view to extending upon the research within the previous chapter by exploring a range of organisational related influences on work driving behaviour such as fatigue, mobile phone use and time pressure. Furthermore, the concepts such as fatigue, time pressure, distraction and mobile phone use are also consistent with potential determinants of injury and crashes outlined within the first level (driver and passenger) and fourth level (organisational environment and work arrangements) of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007).

The results were somewhat disappointing with only driving exposure and the new factor (associated with items relating to symptoms of fatigue/distraction) found to be predictive of self-reported traffic violations. Furthermore, the factors incorporated within the logistic regression model only accounted for approximately 6% of the variance (R^2 = .064). These limitations notwithstanding, the positive results associated with driving exposure were consistent with the results reported in the previous study in Chapter Five. However, in contrast to the previous study, driving errors in the current study were not predictive of self-reported aberrant driving outcomes. This result may suggest that although drivers do make errors while driving, within the current sample, items reflecting other potential influences such as fatigue and distraction appear to be better indicators of risky driving. It is further possible that drivers may have reported lower error scores on account of attributing their risky driving to other underlying influences such as fatigue and distraction.

In addition, the results demonstrating the impact of fatigue/distraction on traffic violations are consistent with the constructs included in the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) and consequently provide evidence supporting some of the potential determinants to crashes identified within

the model. However, further empirical investigation of other potential determinants included within the model is required.

In regards to the first objective of this program of research, the results of this study in conjunction with the previous study would indicate that while some items within traditional measures appear to be associated with risky driving behaviour, there is limited evidence that they can accurately predict crashes and offences within Australian fleet settings. The importance of this finding should not be understated given that the Driver Behaviour Questionnaire is the most widely used driver behaviour scale in road safety research (Winter & Do Dou, 2010). However, in the initial two studies in this thesis, the Driver Behaviour Questionnaire has not proven very effective in predicting crashes or offences respectively for Australian work drivers. It is acknowledged that crashes and traffic offences were self-reported in nature and consequently may not be sufficiently reliable or valid in comparison to actual crashes and offences. However, the limitations associated with these variables and their operationalization will be discussed in detail in the final chapter of this thesis.

Therefore given the results obtained at this stage within this current program of research, it is clear that additional concepts to those incorporated within previously designed measures are worthy of further exploration, especially within the context of developing a work driving risk assessment measure. Furthermore, while there are numerous potential determinants of injury and crashes proposed within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007), more specific exploration determining which factors primarily influence Australian work drivers is required. This is the primary task of the following chapter.

Note: A copy of the questionnaire can be seen in Appendix A

Chapter 7: Identifying Influences of Driving Behaviour: Could the Australian Work Related Driving Setting be Unique?

7.1 INTRODUCTORY COMMENTS

The results obtained from the first two studies in this current program of research demonstrated limited ability for previously designed self-report measurement tools to predict self-reported crashes and offences within Australian vehicle fleet settings. However, there were some results demonstrating the potential value of assessing other organisational and environmental factors influencing work driving behaviour. These factors were consistent with the Occupational Light Vehicle Use Systems Model, which outlines a multitude of potential determinants to injuries and crashes within light vehicle fleet settings (Stuckey et al., 2007). Therefore, the primary focus of the study reported within this chapter is to further explore work related driving to identify additional factors that may influence work related driving safety.

Accordingly, this chapter endeavours to address the second objective of this doctoral thesis research by investigating drivers' perceptions regarding what influences their driving behaviour within the Australian organisational driving context. Furthermore, it is undertaken to answer the second research question:

What are the predominant factors that drivers believe influence driving performance within Australian work related driving settings?

To address this objective and related research question, the study documented within this paper reports on the results of a number of focus group discussions undertaken as part of a series of workshops delivered within the Australian organisational fleet setting. The primary objective of these discussions with organisational drivers across a wide sector of the community was to explore their perceptions as to the major influential factors that impact on their work related driving behaviour. Given the limited ability of previously designed measures to

predict crashes and offences, it was believed that directly assessing active driver perceptions of factors influencing their driving behaviour would assist in further informing the development of an enhanced self-report work driving risk assessment measure.

Consequently, the methodology utilised within this current chapter used an open ended approach in seeking opinions from work drivers regarding influences to their current driver behaviour within the Australian context. A total of 217 employees from environmental and construction departments in a large Queensland based organisation participated in the focus groups. The results of this process will be further utilised to guide item development in a self-report assessment measure.

The paper outlining this study is presented as published in the proceedings of the 5th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.

7.2 AUTHOR STATEMENT OF CONTRIBUTION

In the case of this chapter presented as published, the authors listed below have certified that:

they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

there are no other authors of the publication according to these criteria;

potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and

they agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

Contributor	Statement of contribution
Mr. Darren Wishart	Involved in all aspects of project conception, industry negotiation, proposal, experimental design, data collection and analysis. Co authored manuscript.
Prof. Jeremy Davey*	Advised experimental design, data collection and analysis. Co authored manuscript.
Dr James Freeman*	Advised, experimental design, data collection and analysis. Co authored manuscript.
Mr Bevan Rowland	Contributed to experimental design, data analysis. Co authored manuscript.

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Dr. James Freeman Date: 18/11/2013

7.3 PAPER THREE

Wishart, D.E., Davey, J.D., Freeman, J.E., Rowland, B.D. (2009). Identifying influences of driving behaviour: Could the Australian work related driving setting be unique? *Proceedings of the 5th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Big Sky, Montana, June 22-25.*

7.4 SUMMARY

Work-related driving safety is an emerging concern for Australian and overseas organisations. An in depth investigation was undertaken into a group of fleet drivers' attitudes regarding what personal and environment factors have the greatest impact upon driving behaviours. A number of new and unique factors not previously identified were found including: vehicle features, vehicle ownership, road conditions, weather, etc. The major findings of the study are discussed in regards to practical solutions to improve fleet safety.

7.5 INTRODUCTION

Work related road safety is an area that previous research has consistently identified as impacting heavily on both the general community and business sectors (Davey & Banks, 2005), as a high proportion of work-related deaths and injuries are associated with road incidents**.** Therefore, there is a need to allocate resources, improve current knowledge and develop interventions that reduce work-related road safety risks. However, relatively little research has examined the self-reported driving behaviours of those who drive company sponsored vehicles and/or spend long periods of time behind the wheel (Newnam et al., 2002; Sullman et al., 2002). Nevertheless, a small body of research suggests that company car drivers are at a greater risk of crash involvement than general motorists due to their exposure to the road and associated work-pressures (Newnam et al., 2002; Sullman et al., 2002). Preliminary research has also indicated that self-reported data provided by fleet drivers can be utilised to predict crash involvement (e.g., Davey et al., 2006) and demerit point loss i.e., committing a higher number of errors (Davey et al., 2006; Davey et al., in 2007). However, apart from these initial findings, very little research has endeavoured to examine fleet drivers' self-reported road safety attitudes and driving behaviours, or the link such factors have with incurring infringement notices. What remains evident is that considering the tremendous amount of kilometres

driven by professional drivers within Australia each year there is a genuine need to identify and address factors predictive of road crashes.

This research, along with many road safety initiatives are often driven by models of driving behaviour. While previous research has proposed a variety of factors that may influence driving behaviour (Sullman et al. 2002; Freeman et al., 2007), one of the most widely cited models is that of Lonero and Clinton (1998). This model indicates influences that determine drivers' current behaviour. The researchers argue that both ability and motivation are important to driving behaviour, and suggest that an individual's driving behaviour can be influenced by a variety of dynamic factors that do not necessarily remain static. For instance, although a variety of influences may be present they may be situational specific and likely to invoke differing levels of influence depending on an individual's current driving circumstance. Furthermore, Lonero and Clinton suggest that the strengths of these influences may differ simply due to the proximity or immediacy of the influences. This model is also widely applicable within many transport authorities' crash investigations and corresponding databases, as similar to the model, a broad range of contributing factors to crashes have been identified, including driver and road conditions. For example, Queensland Transport (2001) lists factors contributing to crashes such as; disobeying Road Rules, alcohol/Drugs, speed, inexperience, etc. Many of these factors contributing to crashes fit within the broader context and framework provided by Lonero and Clinton (1998).

Questions remain as to the predominant factors that influence driving performance in fleet settings, and whether differences exist between general motorists and professional drivers. A recent Australian study has indicated that individuals driving for work within an Australian fleet setting may experience many other and somewhat unique factors that also influence driving behaviour (Freeman et al., 2007; Davey et al., 2007). These studies reported that participants were more likely to speed while driving for work, although drivers who perceived speeding as serious were less likely to actually engage in this behaviour within the previous six months. Participants that drove further distances were less likely to report positive attitudes toward road safety and a higher level of perceived work pressure was more likely to result in higher frequency of crashes. Furthermore, the results also suggested that drivers were more at risk due to tiredness, fatigue and loss of

concentration and distractions and importantly fatigue and driving while tired predicted demerit point loss over and above exposure factors.

Nevertheless, one similarity with the general driving population is that a range of factors have also been proposed to influence crash involvement within fleet settings. For example, anecdotal evidence throughout company-funded investigations of a number of large diverse vehicle fleets within Queensland has revealed that the most common types of crashes accounting for the vast majority of fleet incidents are represented by: (a) reversing (b) "rear-enders" and (c) damage while parking. Additionally, such crashes are most often attributed to road conditions, loss of control and animal related incidents (Wishart & Davey, 2004). Interestingly, these crash categories appear to be a reflection of a combination of a blameworthy and asset management approach to crashes and fail to provide any insight into the perceptions, attitudes, safety climate and organisational culture contributing to crashes through the influence on human behaviour. As a result the current research project aimed to conduct an exploratory investigation into a group of fleet drivers' attitudes regarding what personal and environment factors have the greatest impact upon their driving behaviours. Specifically, the research aimed to: (a) What are the major influences to fleet driver's behaviour when at work? and (b) are such factors identified within predominant driving behaviour models (e.g. Lonero & Clinton, 1998)?

7.6 METHOD

7.6.1 Participants and procedure

The focus groups were conducted as a component of a series of workshops undertaken with participants working within environmental and construction departments within a large organisation operating a vehicle fleet. The participants were all people that voluntarily attended the focus group sessions and indicated that they drive operational vehicles as a component of their work. A total of 217 participants (160 males, 57 females) were included in focus groups. The average age of participants in the sample was 41 years with an average of 23 years driving experience. The work roles within the sample comprised 91 field workers, 76 office workers and 50 workers indicating that they worked in both field and office roles. The most common types of vehicle driven for work were 115 participants drive

sedans, utilities or station wagons, 95 drive 4 wheel drives, and 7 drive trucks. One hundred and forty two participants indicated they drive less than 20 000 kms per year and 70 drive between 20 000 and 50 000 kms for work annually. Five participants reported driving in excess of 50 000 kms per year for work. Participants were asked "What are some of the influences to your own driving behaviour when driving for work?" Additional probing questions were employed to clarify and or expand on the meaning or issues highlighted by participants during the focus groups. For example if participants indicated that work pressure influenced their driving behaviour when driving for work they were asked "Can you further explain what you mean by that?" Responses from participants were recorded by another researcher present in the room and were written down verbatim.

7.6.2 Analysis of Data

An inductive "open" coding technique developed by Strauss (1987) was implemented that entails re-reading the text, focusing on and coding the attitudes and perceptions that emerge from the text (e.g., themes), and developing and revising such codes. A coding book was developed and the reliability of the coded schemes was addressed by having the transcripts independently coded by a second researcher. Participants' relatively brief responses to questions complemented this approach, and making verbal recording of responses was not undertaken to ensure anonymity and confidentiality. Furthermore, it was felt that if participants were assured of not being identifiable outside the confines of the workshop group then they make speak more freely regarding their work related driving behaviour and potential influences to those behaviours.

7.7 RESULTS AND DISCUSSION

The first series of questions focused on identifying the major influences to fleet driver's behaviour when at work. As depicted in Table 7.1, the major themes (and thus influences) that were identified included:

Table 7.1: Major influences to fleet driver's behaviour

Fatigue	Speed limits	Impatience
Knowledge of risk	Experience	Anger
Frustration	Other drivers	Health
Mood	Passengers	Culture (Movies, music)

Not surprisingly, many of the factors of influence identified by the participants are the cornerstones of current road safety campaigns for example fatigue, health, alcohol drugs, and speed. It is noteworthy that such factors have also been accounted for in as conditions influencing driver behaviour as conceptualised by Lonero and Clinton (1998).

However, it is noteworthy that a number of new themes emerged that related to a range of vehicle and environment related factors. In regards to the former, six new themes were identified which encompassed: (a) make of vehicle, (b) vehicle load, (c) vehicle features (positive & negative), (d) vehicle ownership and (e) vehicle limitations (see Table 7.2). Firstly, the make and model of the vehicle may prove to have a large effect on the driving outcomes of fleet drivers. For instance, drivers commented on differences between 4 wheel drive vehicles and sedans and indicated that a 4 wheel drive will get them to locations in terrain that would be impossible to travel in a sedan. Secondly, drivers commented on the manner in which different types of loads being transported by their vehicles can influence the type of driving that they undertake. For example, a number of drivers discussed the differences between carrying loads comprising liquid versus a solid load, whereby a liquid load is continuously moving as a result of the constant motion of the vehicle combined with the structure of the road. Drivers commented that if carrying a liquid load then their driving requires more attention with constant changes to the vehicle operation as a result of the shifting of load and weight distribution. Vehicle features were identified by drivers as a further influence of their driving with comments reflecting that various vehicle features could have either a positive or negative influence on

driving. For instance, modern vehicles having cruise control can have a positive influence by preventing speeding although conversely modern vehicle are also capable of travelling at much higher speeds than posted speed limits and are also extremely well designed for comfort. Subsequently, drivers commented that due to modern vehicle design you are not aware that you are driving faster than the speed limit as it doesn't feel that fast and there is reduced noise.

Participants also acknowledged that driving a company supplied vehicle was different to driving your own vehicle and that employees did not care as much about the company vehicle in comparison to their own. The participants suggested that this may subsequently influence the way in which people drive or even care for a company car. The final sub theme identified as vehicle related referred to possible limitations of specific vehicles with comments indicating that although certain vehicles may be perceived as similar, there are often differences in handling abilities which need to be accommodated by drivers across various conditions and requirements of use.

Environmental conditions incorporated themes such as (a) weather, (b) road conditions, and (c) distance required for travel (see Table 7.2). Participants referring to weather conditions discussed the implications of extreme weather conditions often experienced within various regions. For instance, extreme wet experienced in remote areas of Australia may require drivers to not only travel slower but also take alternate routes. In contrast, extremely harsh temperature conditions are experienced within summer months and can be even more extreme in remote areas.

The road conditions appear to influence drivers in two distinct ways. Firstly, the poor condition of the road can influence drivers to take extra precautions. Alternatively, roads that have been upgraded or are in remote locations can be straight for extended periods of time, resulting in drivers experiencing boredom and possibly fatigue. Furthermore, to combat boredom drivers admitted to driving faster if the road was also straight with a view to arriving at their destination in a shorter time indicating that they just wanted to get the trip over and done with. Finally, extended travel distances was cited as encouraging drivers to speed, although drivers also suggested that extended distances force them to take more precautions as in remote locations there is little opportunity to assistance should something go wrong.

Drivers also commented that extended travelling distances influences them to share the driving.

It is also suggested that some of the themes previously identified in Lonero and Clinton (1998) could be expanded to incorporate a number of sub themes established within the current focus group research. The sub themes identified included; *Personal life issues*, *Issues at work, Response to emergency situation*, *Knowledge of the route and Familiarity and unfamiliarity of the area or route, Over and under confidence*, *Potential consequences of unsafe driving.*

Table 7.2: Participant responses in relation to vehicle related factors and environmental conditions

Theme - Vehicle	Example	Theme - Environmental	Example
Vehicle related	These issues all relate to the manner in which factors associated with the vehicle can influence driver behaviour while driving for work.	***Environmental conditions***	Environmental conditions is a theme that incorporates issues influencing driver behaviour that relate to the type of driving environment work related drivers operate their vehicle in.
Make model of vehicle	"The make and model of vehicle has an influence on how we drive. For example how I drive a 4wheel drive Landcruiser is not the same as how I drive a commodore. I know the Landcruiser can get me to places that you wouldn't even think about going in a commodore."	*Weather*	If we've had really bad weather up here then I certainly drive much slower, maybe also drive a different way to get there (different route). Depending on the time of the year… like it can get really hot here in summer… well I just want the day to end I want to get back in the cool.
Vehicle load	"I drive differently depending on the type of load I am carrying, say I have a load that is liquid well I'm going to drive differently than if the load was something solid and couldn't move. Liquid can move within the container and all of a sudden you have got all the weight of your load on one side of the vehicle."	*Road conditions*	Some of the roads are pretty ordinary, we don't just drive on bitumen some of the dirt roads are pretty tricky and you might have to slow down a fair bit. The straight roads make it pretty boring and I just want to get there so the roads are pretty good with not a lot of other vehicles so I probably drive faster
Vehicle features (positive influence)	"Vehicle features can change the way you drive. If a vehicle has cruise control then maybe it helps me not to speed as I can just set the cruise control."	*Distance required for travel*	"I certainly take more precautions if I am driving longer distance." "We travel such long distances and it gets really boring especially on the straight roads out here, so you tend to go a bit faster just 'cause you want to get there." "If we have a lot of driving to do we tend to take turns driving"
Vehicle features (negative influence)	"Some of today's vehicles are so well built and powerful that you can drive over the speed limit and you don't even know you are doin' it." "Engineering designs of today's cars make them more comfortable, like you can't even hear any noise. They're also capable of going at speeds much faster than the speed limit."		
Own vehicle versus company vehicle	People probably drive company cars a bit different to their own car.		
Vehicle limitations	"Some of the vehicles we have to use are no good for things like towing. They lack power so I have to take this into consideration when I am driving with a load up the range (mountain)." "Some vehicles just don't handle as well as others so you have to account for this in your driving."		

Participant comments also provided specific indicators as to the manner in which many of these sub themes could influence work related driving behaviour. It should also be acknowledged that many of these themes could have either a positive or a negative influence. For example a participant's lack of knowledge of the area or route in some instances may contribute or influence a driver to drive a vehicle more carefully. For instance, a driver driving in an area that is unfamiliar may drive slowly due to a lack of knowledge and perception of potential difficulties in road surface or potential hazards around the next bend. Alternatively, this same lack of knowledge or unfamiliarity may contribute to adverse driving behaviour due to the driver not possessing or being aware of the specific dangers associated with this particular environment.

Participants highlighted the issue of responding to an emergency situation. Although this could indicate an influence on driving behaviour that relates to time pressure, comments from participants also reflected the impact on their driving behaviour that related to the adrenalin rush that they experienced when responding to an emergency incident. Participants discussed the manner in which the adrenalin can influence the way they drive and highlighted that if they do not keep the adrenalin levels in check then they are more likely to take more risks and focus attention solely on arriving at the destination as quickly as possible.

Over or under confidence of the driver was also identified as a factor contributing to driver behaviour. Examples from participants suggested that an over confidence in one's ability could influence the vehicle operators to take increased risks. Alternatively, drivers experiencing a lack of confidence indicated that they were more likely to make errors of judgement and also be more likely to be influenced by other drivers.

Finally, participants commented that if they thought the consequences associated with driving unsafe were severe enough then they may be likely to take extra precautions. For example, some participants indicated that a serious crash would compromise their lifestyle and impact on young family thus influencing them to drive safer.

7.8 CONCLUSION

The purpose of this research was to investigate the factors that influence work related drivers in Australian fleet settings. Not surprisingly, many of the factors influencing driver behaviour that were identified by participants are the focus of standard road safety campaigns and have been conceptualised and identified in previous research. However, a number of new and unique factors influencing driver behaviour have been identified within this research. Primarily, these influences relate to issues associated with vehicles and the particular road environment experienced within Australia. Interestingly, vehicle related issues could have either a positive and negative effect on driver behaviour. The results of this research suggest that some vehicle features and technological improvements while designed to increase driving comfort safety and performance may actually have some adverse effects on driver behaviour. It is suggested that these vehicle influences may have implications for fleet procurement personnel to develop comprehensive vehicle fit for purpose criteria.

The results also indicated specific issues associated with the environment which may be in contrast to environmental conditions experienced within other countries. For example, due to the vast distances travelled within Australia many roads are designed to continue for long straight sections which although reducing hazards associated with bends in the road may contribute to further issues associated with fatigue.

In conclusion, this research has revealed a number of factors influencing work related driving behaviour that may be specific to Australian fleet settings. It is suggested that future research further explore these issues to determine the level of impact that these factors have on drivers operating vehicles across various sectors of the Australian workforce.

7.9 CHAPTER SUMMARY

The study reported within this chapter sought to address the second objective of this thesis by conducting a series of open ended discussions with groups of Australian fleet drivers to investigate their perceptions regarding what influences their behaviour when driving for work. In addressing this objective, this study also attempted to answer the second research question by identifying the predominant

factors that drivers believe influence their driving performance within the Australian work related driving settings. The results obtained within this study (although highlighting a range of influences on driver behaviour consistent with general road safety initiatives), did identify a variety of new themes that appear to influence work related driving behaviour particularly within Australian fleet drivers. Importantly, some of these identified influences are not adequately incorporated within current self-report measures. For example, some of the themes identified within this study included: positive and negative influences of vehicle features, the impact of distance required travelling as part of work, and limitations associated with various vehicles and job requirements. Nevertheless, it is noted that some of the concepts identified within this study do appear consistent with broad themes identified as potential determinants within various levels of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). For instance, the influences associated with weather and road conditions identified in this study are consistent with the external work and road environment level of Stuckey et al.'s (2007) model.

However, although some of these themes are similar to those conceptualised by Stuckey et al., (2007), a number of those identified by participants within the current study reflect additional influences worthy of further discussion. For example, reference to the potential determinants consistent with the external environment level in the Occupational Light Vehicle Use Systems Model, primarily refers to adverse effects of such determinants as contributors to injury and crashes (Stuckey et al., 2007). The concepts and potential determinants identified within the model such as weather and road conditions, primarily refers to the negative effects of adverse weather and road conditions on work driving. In contrast, the results of the discussion groups in the current study also identified how factors such as poor weather and road conditions can potentially encourage drivers to drive in a safer manner. In addition, while vehicle safety features are often referred to in road safety strategies as an intervention to reduce or prevent crash or injury (Australian Transport Council, 2011), participants' responses highlighted the potential of some of these technologies to influence or contribute to unsafe driving within the work setting. Consequently, while some of the themes identified within this current study provide some evidence of support for a number of potential determinants within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007), they also

demonstrate the complexity of the influences on drivers and that some factors may have a bidirectional impact on driver behaviour. As such, the additional themes identified may also contribute to advancing Stuckey et al.'s (2007) model, by reconceptualising some of the components within the model.

Finally, in regard to this current thesis, although this study has identified a variety of extra factors for consideration in the progress and development of identifying both drivers at risk and particular risky driving behaviours, the implications associated with the results do present some further difficulties and issues for consideration. For example, in addition to the five levels and in excess of one hundred potential determinants conceptualised by Stuckey et al., (2007) within the Occupational Light Vehicle Use Systems Model, the results of the discussions with work drivers in the current study identified an even wider range of potential influences on their behaviour. Importantly, some of the influences identified also have the potential to affect work driving behaviour in both a positive and negative manner. Therefore, there may be implications associated with the positive and negative influences of factors that need to be taken into consideration when not only developing work driving assessment measures, but also in the interpretation of results.

A final dilemma associated with additional influences being identified within the current study, is the potential to make already unwieldy self-report measures even more lengthy and impractical for administration within organisational settings. This exacerbates issues previously identified and discussed within the conclusions of the study reported within chapter five of this thesis.

In summary, although this paper has identified a number of new potential influences on work driving behaviour, the manner in which they impact on drivers (positively or negatively) may require further consideration. In addition, the results indicating the potential bidirectional nature of some of these influences further highlights difficulties associated with predicting unsafe driving behaviour.

The research contained within this thesis to date was undertaken across an expanse of time of approximately seven years, during which time other research in the work related road safety area had also progressed. At the commencement of this current research program, research within the work related road safety area was limited and progress was slow, certainly within the Australian context (Wishart et al.,

2006; Newnam & Tay, 2007). However, during the course of the current research, progress and attention to work related driving has rapidly increased as a likely consequence of changes in legislation (Work health and Safety Act, 2011; ISO39001, 2012) and industry concerns (Wishart & Rowland, 2010). Therefore, the following paper presented as chapter eight endeavours to synthesise the developments, which occurred within the work related road safety field during the time the program of research was being undertaken, along with associated considerations for the remainder of the research.

Chapter 8: Developing Risk Assessment Tools for Fleet Settings: Where to from here?

8.1 INTRODUCTORY COMMENTS

The third objective of this program of research was to identify current and emerging issues impacting upon the development of self-report driving risk assessment measures within the work driving setting. The first two studies within this thesis demonstrated that the Driver Behaviour Questionnaire (Reason, et al., 1990), one of most widely used self-report measures (Winter & DoDou, 2010), along with the Driver Attitude Questionnaire (Parker et al., 1996); and Safety Climate Questionnaire (Glendon & Litherland, 2001; Wills, et al., 2005) showed limited success in predicting crashes and offences within the Australian work driving setting. The third study within this thesis identified a number of additional factors which appear to influence drivers in various ways within a work setting (eg., fatigue, frustration, extended travel distances, environment, etc.). However, further exploration of these factors and their potential to influence work driving behaviour is required.

In addition, much of the research direction in developing a risk assessment measure for Australian work settings to date has primarily focused on the driver and subsequent driver behaviour as the unit of measurement. While this approach does not appear unwarranted, the results obtained to date suggest that some of the difficulties associated with a lack of predictability in some of the previous measures may be attributed to a too narrow focus of the measures, particularly in terms of focussing on individual level factors associated with driver behaviour (eg., speeding aggression, errors, etc.) in contrast to broader organisational issues such as work task design resulting in time pressure, fatigue, distraction or multitasking and vehicle related issues such as maintenance. Furthermore, the lack of efficacy of these measures to accurately predict crashes and offences is consistent with the tenets of work driving risk management and the theoretical framework offered by Stuckey and colleagues (2007) who argue that in order for work related road safety to improve, it

must firstly recognise the vast array of influences on drivers within the complexity of today's working environment and secondly integrate approaches to ensure consistency with occupational health and safety legislative requirements. During the course of research within this thesis, other researchers have also been attempting to develop reliable and accurate risk assessment measures that are capable of predicting crashes (Dorn & Gandolfi, 2008; Dorn Stephen, af Wåhlberg & Gandolfi, 2010).

Due to the span of time involved longevity in undertaking the research for this doctoral thesis (approximately 7 years) it was also considered timely to provide an update and overview of progress associated with other work related road safety research undertaken to predict driver risk within the self-report domain. Therefore, the following paper presented as Chapter Eight was written and published to provide an update of progress in the field and to synthesise the results, conclusions, and inherent direction undertaken within this current doctoral dissertation.

8.2 AUTHOR STATEMENT OF CONTRIBUTION

In the case of this chapter presented as published, the authors listed below have certified that:

they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

there are no other authors of the publication according to these criteria;

potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and

they agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

Contributor	**Statement of contribution**
Dr James Freeman	Co authored manuscript.
Mr. Darren Wishart	Co authored manuscript.
Prof. Jeremy Davey	Co authored manuscript.
Mr Bevan Rowland	Co authored manuscript.

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Dr. James Freeman Date: 18/11/2013

8.3 PAPER FOUR

Freeman, J.E., Wishart, D.E., Davey, J.D., Rowland, B.D. (2010). Developing Risk Assessment Tools for Fleet Settings: Where to From Here? In Dorn, Lisa (Ed.) *Driver Behaviour and Training, Vol.IV.* (pp. 241-256). England: Ashgate.

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http://www.ashgate.com/isbn/9780754672036

8.9 CHAPTER SUMMARY

At the time of commencing this program of research to undertake the development of a work related road safety risk assessment measure, throughout the world there was little empirically driven research specifically focussing on work related driving safety, risk identification and risk management. Although, it is acknowledged that many organisations operating vehicle fleets were aware of the magnitude of the problem within their specific organisation, the approach to

improving work related road safety, as has been previously discussed in this thesis, was reactive, ad hoc and relatively inconsistent.

The paper documented in this chapter was prepared in response to increased research focus on work related road safety, self-report measurement tools and work driving risk assessment (at a global level) since the initial commencement of the current research program. Consequently, the aim of this paper was to provide an update, highlighting recent research directions in work related driving measurement tool development. Accordingly, the paper addressed the third objective of the current research program by identifying current and emerging issues that impact upon the development of self-report driving risk assessment measures within the work setting.

Interestingly, other international researchers are also moving away from utilising traditional driver behaviour measures such as the Driver Behaviour Questionnaire toward more tailored driver risk assessment measures to ascertain crash risk (Dorn, Stephen, Af Wåhlberg & Gandolfi, 2010). However, although these measures are increasingly being utilised in numerous organisations, in regards to accurately predicting crashes, empirical results are yet to be firmly established (Dorn et al, 2010). Consistent with the research thus far documented in this thesis, other researchers investigating work driving risk assessment appear to be grappling with similar issues associated with establishing the predominant underlying factors influencing work driving crashes (af Wåhlberg et al., 2011; af Wåhlberg , 2009; Dorn & Gandolfi, 2012; Dorn et al, 2010).

Future challenges in the development of self-report risk assessment measures relate to not only identifying what driver and organisational processes are the most salient in contributing to risky driving behaviour, but also to establishing the best outcome measures representative of risky driving (e.g., crashes, fines and/or near misses).

A Key feature of recent research into the development of work driver risk assessment measures has been the use of technology to deliver online measurement tools. While the use of the World Wide Web enables researchers to easily reach a wider audience, caution needs to be exercised in regard to the premature promotion of driver risk assessment measures that lack empirical rigour and consequently still may be ineffective in actually predicting driving risk outcomes such as crashes. Since the commencement of the current research, the use of the internet has expanded

exponentially, and consequently, there is an ever increasing amount of research that utilises the on-line administration of surveys and measurement tools (Freeman & Davey, 2008; Darby et al., 2009; Dorn, Stephen, af Wåhlberg & Gandolfi, 2010). Extensive use of online technology to administer measurement tools before they undergo sound empirical development may exacerbate a perception that the measures are valid.

Further direction about how best to develop and use these tools would be obtained from direct examination of industry case studies and organisational work driver processes. For example, research undertaken within the work related driving safety settings by the author of this thesis and colleagues identified a series of consistent gaps and deficiencies in organisational work related driving safety processes across a number of organisations (Wishart et al., 2011). In this study, specific deficiencies evident across organisations included a lack of comprehensive policy relating to work driving, lack of sufficient detail of incidents and processes associated with reporting and recording, and a lack of communication and promotion of strategies associated with promoting safe work related driving. Thus within the context of these organisations, both "safe" and "unsafe" drivers could be inadvertently influenced to adopt unsafe driving behaviour as a result of the deficiencies in organisational work driving procedures and poor organisational driving safety management.

Consequently, if deficient processes exist within the organisation that compromise driving safety, then "safe" drivers may be encouraged or influenced within the organisational context to adopt "unsafe" driving behaviours consistent with the deficient organisational safety processes. In contrast, "unsafe" drivers may simply continue in their "unsafe" behaviours associated with driving as they may be perceived as consistent with the organisational safety requirements, despite those requirements being extremely lacking in safety processes.

The results of the previous stages of research incorporated within this thesis and the renewed vigour in work related road safety research reported within this chapter, have a number of implications for the further development of a self-report risk assessment measure for Australian fleet drivers. Firstly, as has been earlier reported in this thesis, previously designed measurement tools such as the Driver Behaviour Questionnaire, Driver Attitude Questionnaire and Safety Climate

Questionnaire appear to possess limited ability to accurately predict risky driver behaviour within Australian settings in the form of crashes and offences. Consequently, there appears to be a need for a risk assessment measure for use in Australian settings to incorporate additional items assessing a broader scope of influences on work driver behaviour. Secondly, the focus of international research now appears to be on the development of tailored measures to meet the specific needs of industry groups (Dorn & Gandolfi, 2008) suggesting that measures may need to be highly specific to particular industry activities and requirements. For instance, it is suggested that the needs and activities associated with the taxi industry incorporating 24 hours a day shifts, long hours driving, and extensive kilometres travelled may be quite different to the needs and activities of local government sector organisations where the predominant travel is within normal (9am-5pm) work hours and occurs within a distinct geographic location of the local government precinct. Finally, the paper documented in this chapter indicated the apparent bi-directional nature of influences associated with the working environment and other work conditions. For instance, it appears that in vehicle safety technology as well as road environment features and conditions have the potential to influence driving behaviour in both a positive and negative manner, depending on the individual and the circumstances.

Consequently, the self-report risk assessment measure administered and outlined in the next stage of research incorporates a renewed focus on the factors influencing work driving by incorporating additional items associated with organisational processes and procedures consistent with safer management of work related driving.

Chapter 9: When Non-significance maybe significant: Lessons learned from a study into the Development, Implementation and Evaluation of a Risk Assessment Tool for Fleet Settings

9.1 INTRODUCTORY COMMENTS

The following chapter outlines the development and implementation of a newly devised self-report risk assessment measure. The study was undertaken to address the fourth objective of the program of research investigating the ability of a newly devised self-report work driving risk assessment measure to predict crashes and offences within the light vehicle fleet context. In addition, this study attempts to answer the third and fourth research questions underpinning the program of research:

> ***Can environmental, organisational, and driver related factors that influence work related driving predict crashes and offences within a fleet environment?***
>
> ***Can a newly devised work driving risk assessment measure identify risky drivers by predicting crashes and traffic offences within the Australian work related driving context?***

The work related driving risk assessment measure examined in this study was deemed to more fully encompass the range of factors known to influence work driving. Firstly, it incorporated various factors shown to be important in the earlier published studies contained within this thesis, such as work pressure and fatigue (as documented in Chapters Five and Six). Secondly, it incorporated items that were generated in response to the findings of the focus group study reported in Chapter Seven, such as speeding or driving differently as a consequence of modern vehicle improvements. In addition, the self-report measure also incorporated concepts related to organisational work related driving and risk management as outlined in Chapter Two.

Accordingly, a strong focus on the current study was on generating new items that reflected the risk factors identified in earlier stages of the research, such as speeding and aggression. Development of a new measurement tool also required the

incorporation of items reflecting a wider range of organisational influences on driver behaviour. In other words, items generated related to a broader range of concepts believed to influence work driving behaviour that were not included in previously utilised traditional self-report measures. For instance, concepts and potential influences on organisational driving behaviour such as time pressure, fatigue, and distractions (such as mobile phones use), lack of vehicle maintenance and lack of psychological ownership or responsibility in relation to company vehicles were developed to be included in this study. In addition, many of these concepts represent potential determinants of crashes identified at various levels within Stuckey et al, (2007) Occupational Light Vehicle Use Systems Model. For example, potential determinants of crashes within the driver and passenger level in the model include influences such as overall driving exposure as well as patterns of driving including requirements to drive home after long working days, along with individual factors such as mood or state of mind while driving. Furthermore, the findings of the focus group study suggest there would be value in including items designed to assess the immediate physical work environment level conceptualised by Stuckey et al., (2007), including features associated with the vehicle used and procedures around vehicle maintenance. For example, it was decided to include items reflecting activities such as conducting pre start maintenance checks and driving differently due to modern day vehicle features represent these concepts.

Items were also developed that related to Stuckey et al.'s, (2007) extended work environment level, assessing behaviours associated with dealing with other road users and traffic congestion such as indications of frustration regarding driving in traffic (*Driving in traffic makes me extremely frustrated)*. Other items included in this study also assessed concepts associated with the organisational environment component within the Occupational Light Vehicle Use Systems Model. These items reflect concepts such as work arrangements, work demands and work activities, such as driving while under time pressure from other work demands, or management expectations along with business demands requiring the use of mobile phones within the vehicle environment. Other items included in the revised measure assessed the influence of specific legislative requirements such as illegal mobile phone use and speeding. While these items therefore provided some insight into the influence of factors contained within the fifth level of the Occupational Light Vehicle Use

Systems Model, they more directly assessed individual driver behaviour (i.e. the first level of the model).

Although this chapter focusses on the development and assessment of the revised measure, it also discusses the implications of the results in regards to the ongoing development of risk assessment measures for the work driving context. The paper as published is presented below.

9.2 AUTHOR STATEMENT OF CONTRIBUTION

In the case of this chapter presented as published, the authors listed below have certified that:

They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

There are no other authors of the publication according to these criteria;

potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit, and

They agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

Contributor	Statement of contribution
Mr. Darren Wishart	Involved in all aspects of project conception, industry negotiation, proposal, experimental design, survey design, data collection and analysis. Co authored manuscript.
Dr James Freeman	Advised experimental design, survey design, data collection and analysis. Co authored manuscript.
Prof. Jeremy Davey	Advised, experimental design, data collection and analysis. Co authored manuscript.
Mr Adrian Wilson	Contributed to experimental design, survey development, data analysis. Co authored manuscript.
Mr Bevan Rowland	Contributed to experimental design, survey development, data analysis. Co authored manuscript.

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Dr. James Freeman Date: 18/11/2013

9.3 PAPER FIVE

Wishart, D.E., Freeman, J.E., Davey, J.D., Wilson, A., Rowland, BD. (2012). When Non-Significance Maybe Significant: Lessons Learned from a Study into the Development, Implementation and Evaluation of a Risk Assessment Tool for Fleet Settings. In Dorn, L. (Ed.) *Driver Behaviour and Training Volume V* (pp.197-214). England: Ashgate.

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9.11 CHAPTER SUMMARY

This chapter presented as a published paper outlined the results of a study utilising a newly developed self-report work related driving risk assessment measure that incorporated items reflecting a broad context of factors proposed to influence safe driving. This study was primarily undertaken to address the fourth objective of this program of research which was to develop a new self-report work driving risk assessment measure and investigate the ability of a range of organisational and contextual factors to predict risky driving behaviour within the Australian light vehicle fleet context. Specifically, the study aimed to answer the third and fourth research questions underpinning the program of research:

Can environmental, organisational and driver related factors that influence work related driving predict crashes and offences within a fleet environment?

Can a newly devised self-report risk assessment measure identify risky drivers by predicting crashes and traffic offences within the Australian work related driving context?

In undertaking to answer these questions, the newly devised measure, in addition to incorporating items that were informed and guided by results of the previous research within this thesis, also included items designed to represent various potential determinants conceptualised in each of the various levels within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). For example, consistent within the driver and passenger level of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) the measure included items such as driving exposure, fatigue and other risky driving behaviours. Level's two and three of the Occupational Light Vehicle Use Systems Model relating to immediate and external work environments were represented by items relating to the vehicle, safety features, road conditions and geographical locations of work driving. Items within the driving risk assessment measure relating to the organisational environment (fourth level) assessed influences such as time pressure and work arrangements, mobile phone use requirements and vehicle maintenance practices. The final level of

the model relates to work and public safety legislation and hence items relating to illegal behaviours, such as speeding associated with legislation were also included, although these more directly assess individual behaviours as captured within the first level of the model.

Unfortunately, despite the measure displaying a reasonably sound factor structure, and in some of the regressions operationalising it proving significant, the ability of the measure or any components within it to reliably predict crashes or offences was extremely limited. Further evidence as to the limitations of the measure is demonstrated by the limited amount of variance explained by it in the relevant analyses, with the largest R^2 of any of the regression models being only 0.07. These results indicate that despite incorporating items designed to measure a wider range of influences on driver behaviour, the new measure proved to be no better than those previously utilised measures within this program of research that incorporated even fewer constructs. Furthermore, despite the new measure incorporating a wider range of concepts conceptualised in various levels of Stuckey et al.'s, (2007) Occupational Light Vehicle Use Systems Model, it did not appear to possess any greater empirical utility in predicting crashes, at least in terms of self-reported crashes. Consequently, in regard to the third research question, the results demonstrated that the environmental, organisational and driver related factors used in this study did not meaningfully predict self-reported crashes and traffic offences within a sample of fleet drivers. Disappointingly in regards to the fourth research question, the results also demonstrated that the newly devised work driving risk assessment measure did not identify risky drivers by predicting self-report crashes and traffic offences within the Australian work related driving context.

There are a number of potential implications of these results that are particularly relevant to this thesis, and in particular for the further development of driving risk assessment measures. Firstly, the inability of this measure, or any previous measures used within this thesis, to meaningfully predict self-report crashes and offences may be due to the complexities and interactions associated with numerous factors relating to the driving task. In addition, the various interactions that can occur between these factors may not remain stable over time but rather, change depending on the situation in an ever evolving work driving environment. This premise is consistent with conclusions outlined by Stuckey et al., (2007) indicating

that there are significant gaps in research associated with understanding the problems in occupational light vehicle use and progress toward improvements in work driving safety. Therefore, a better understanding of these interactions is also required to further develop any future work driving risk assessment measures and risk management processes.

It is important to note, however, that these results may simply demonstrate the limitations associated with relying on self-report measures of driving behaviour. If this is the case, the methods used to develop work related driving risk assessment measures and any future development of such measures may have to substantially change. There are potentially a number of specific directions that may assist in guiding future progress of driver risk assessment. Firstly, although this study utilised indicators relevant to both the work and non-work settings (crashes and offences), definitions of the meaning of a crash may differ across participants, resulting in the potential under reporting of relatively minor incidents as they may not be considered by some as representing a crash. The plausibility of this explanation is consistent with previous research that suggests that even within industry settings, there are inconsistencies associated with crash data recording and reporting (Wishart et al., 2007; Murray et al., 2003; Wishart et al., 2011; Wishart, Rowland & Davey, 2010).

Consequently, the utilisation of outcome measures such as crashes and traffic violations ultimately, may not necessarily be the most accurate indicators of risky driving behaviour. For instance, a risk management approach to safety in the work setting suggests that crashes are considered a final outcome indicator, while other performance measures such as speeding are considered immediate safety outcome factors (ISO39001, 2012). In addition, af Wåhlberg et al., (2011) suggest that many commonly occurring traffic incidents may not necessarily reach a level of severity to ultimately result in a crash or traffic offence. Therefore, future research should consider alternative outcome indicators of work driving risk. These indicators may need to incorporate a range of different data sources such as, in vehicle technology, human cognitive and physiological responses, and actual constantly assessed driver behaviour.

Finally, future risk assessment measure development may need to encompass a broader organisational approach incorporating a multitude of aspects associated with not only work related driving, but also organisational managerial and workplace

policies and procedures. The potential for such an organisational approach will be discussed in greater detail in the final chapter of this thesis but could include aspects associated with, policy and procedure audits, direct observations, driver and vehicle monitoring systems, safety culture, and employee and management safety knowledge.

Chapter 10: Discussion

10.1 INTRODUCTORY COMMENTS

As has been highlighted throughout this thesis, previous research has consistently demonstrated that within the work setting, driving is a high risk activity with death and injury involving motor vehicles being over represented in workplace incidents (WHO, 2004; Haworth, et al., 2000; Wishart et al., 2011; Mitchell et al., 2012). In Australia, legislation also exists that outlines requirements for organisations, industry and personnel to manage and mitigate risk associated with work activities, including vehicles (Work Health and Safety Act, 2011; Health and Safety Regulation, 2011; AS/NZ ISO 31000: 2009). An initial step in managing and mitigating risk associated with vehicles used for work is to accurately identify drivers who are potentially more at risk of having a crash while driving. This current program of research presented as a thesis by publication has incorporated a number of studies reported in five peer-reviewed papers. The overall research program was borne out of a need to develop more contemporary self-report work driving risk assessment scales to assist in identifying risky driving behaviour within the Australian light vehicle fleet context. Consequently, this research program has investigated a variety of self-report measures and examined their ability to predict risky driving behaviour among Australian light vehicle fleet drivers.

To achieve this objective, this research firstly explored previously designed self-report measures, developed primarily within an overseas context, and investigated their ability to predict self-report crashes and traffic offences of drivers driving for work purposes. Secondly, this research investigated drivers' perceptions regarding what influences their driving behaviour within the Australian organisational driving context. Thirdly, it explored a variety of factors believed to contribute to work related driving crashes and injury and investigated their ability to predict self-reported crashes within the work context. Fourthly, after considering the outcomes of the first three studies, this research investigated the ability of a newly devised self-report risk assessment measure to predict crashes and offences within the Australian light vehicle fleet setting. Taken together, this program of research has contributed to enhancing knowledge into the development, application and

limitations of self-report work related road safety risk assessment measures within the Australian organisational work driving context.

This final chapter will summarise and discuss the key findings from each of the published papers incorporated within this thesis, and discuss the implications for work related road safety and risk assessment within vehicle fleet settings. It will also discuss the implications of the findings for self-report measures and occupational driving in the wider context. To provide a framework for this final chapter, the findings and interpretation of the results associated with each of the studies and publications included in this thesis, will be reviewed in terms of the overall aim and objectives of the research and the specific research questions underpinning this doctoral thesis.

10.2 REVIEW OF KEY FINDINGS ACCORDING TO RESEARCH OBJECTIVES

Objective 1- Investigate the ability of previously designed self-report measurement tools to predict work related driving risk within Australian vehicle fleet settings.

The findings of Study One (Chapter Five) and Study Two (Chapter Six) provide little evidence that previously designed self-report measurement tools can reliably predict crashes and offences within Australian work related driving settings. In particular, the Driver Behaviour Questionnaire (Reason et al., 1990) which appears to be the most widely used driver behaviour measure in road safety research (Winter & Dodou, 2010) while demonstrating some statistical significance associated between errors and crashes, failed in predicting driver crash involvement with any level of reliability.

Furthermore, Study Two (Chapter Six) extended the investigation by incorporating additional items into the DBQ designed to represent a distinct range of potential determinants to injuries and crashes for work drivers as conceptualised by Stuckey et al., (2007). Despite the inclusion of these additional items, the measure also failed to reliably predict driver involvement in crashes or traffic offences. These findings also have implications for the first research question underpinning the program of research:

Can previously designed self-report measures predict self-reported crashes and offences within Australian work related driving settings?

The key finding from the first stage of this research program is that previously designed measures do not meaningfully or adequately predict self-reported crashes and offences within the Australian work related driving setting. In addition, findings suggest that there may be a wider range of influential factors that may contribute to risky driving behaviour within a work vehicle fleet setting. This interpretation is certainly consistent with the numerous additional potential determinants conceptualised within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). The implications of these findings will be discussed further in the following sections.

Objective 2- Investigate drivers' perceptions regarding what influences their driving behaviour within the organisational driving context.

Given that the results obtained from Studies One and Two demonstrated little evidence of previously designed self-report measures being capable of predicting work drivers crash and traffic offence involvement, Study Three (Chapter Seven) was designed to identify other factors that may influence work driving behaviours of Australian light vehicle fleet drivers. This study consisted of a series of focus groups to elicit drivers' perceptions as to what they believed influenced their work driving and thus answer the second research question:

What are the predominant factors that drivers believe influence driving behaviour within work related driving settings?

It was expected that by seeking this information from actual active drivers, that information obtained would inform further development of items in a new work driving risk assessment tool. While the results of this study identified a range of factors consistent with the findings of previous fleet safety research such as, fatigue, speeding, alcohol and drugs. (Adams-Guppy & Guppy, 1995; Haworth et al., 2000; Mooren & Grzebieta, 2010; Stuckey et al., 2007), a number of other unique factors emerged. Some of these factors aligned with the immediate and organisational external environment component of the Occupational Light Vehicle Use Systems Model, such as vehicles, technology and distance required to travel. However a

number of personal or life issues were also acknowledged such as mood, knowledge of risk, health and anger.

One key finding of this study was the potentially bi-directional nature of some of these influences on driver behaviour. For example, the results highlighted that some influences often conceptualised as facilitating safety such as vehicle safety features can potentially have a negative influence on work driving safety. For instance, participants suggested that in vehicle safety features may influence drivers risk perceptions by encouraging drivers to feel safer. This increased perception of safety may in turn affect their driving behaviour with workers potentially engaging in less safe or precautionary driving behaviours as a result of adjusting their risk perceptions. Conversely, vehicles considered by some participants as less safe had the potential to influence them to take more precautions in their work driving. This finding is consistent with risk homeostasis theory proposed by Wilde (2001) which states that people will accept a certain level of risk in exchange for the rewards they hope to receive and will continuously adjust their behaviour to maintain their "target" or optimum level of risk. As a result, if people perceive the risk as being reduced they may alter their behaviour in a way that subsequently increases risk. Alternatively, according to the same theory, people may perceive that the risk has increased and as a result, may adjust their behaviour to take less risk (Wilde, 2001).

The potential bidirectional nature of these influences has implications for researchers regarding the interpretation of factors and their relationship to behaviours, which in turn has implications for future risk assessment processes and their evaluation. For example, researchers will need to be cautious of presuming that safety initiatives associated with vehicles or the immediate external environment result in only a positive effect on work drivers and subsequently, on relevant safety outcomes. Importantly, in regard to this program of research, the identification of other potential influences on work driving behaviour that were consistent with the immediate and organisational external environment within the Occupational Light Vehicle Use Systems Model, provided an opportunity for this information to guide the development of the revised self-report work driving risk assessment measure examined in Study Five (Chapter Nine).

Objective 3- Identify current and emerging issues that impact upon the development of self-report driving risk assessment measures within the work driving setting.

Typically, a doctoral program of research is undertaken over an extended time frame and during this time research within the area of focus continues to progress. In the current context, research focussing on self-report risk measures applicable to the work driving domain increased substantially over the seven years of this current research program (refer Dorn & Gandolfi, 2007; Dorn, Stephen, af Wåhlberg, & Gandolfi, 2010). Paper four reported on a contextual review undertaken to provide an update of the renewed vigour toward research in this area. Furthermore, this paper also sought to provide an update on situational issues impacting on recent developments of self-report measures, particularly those relevant to the work setting.

A key finding from this paper was that other international researchers were also moving away from utilising traditional driver behaviour measures such as the Driver Behaviour Questionnaire toward more tailored driver risk assessment measures incorporating additional organisational factors considered to influence crash risk (Dorn, Stephen, af Wåhlberg & Gandolfi, 2010). However, consistent with the findings emerging from the earlier studies in this program of research, these researchers were also struggling to establish the predominant underlying factors that can accurately predict crashes in work settings (af Wåhlberg et al., 2011; af Wåhlberg, 2009; Dorn & Gandolfi, 2012; Dorn et al., 2010).

A further finding from this paper was that since the commencement of the current research, the use of the internet had expanded exponentially, and consequently, there was an ever increasing amount of research administering surveys and measurement tools online (Freeman & Davey, 2008; Darby et al., 2009; Dorn, Stephen, af Wåhlberg & Gandolfi, 2010). However, a degree of caution must be exercised in relation to the proliferation of online measurement tools to ascertain whether they are adequately underpinned by scientific rigor. Extensive use of online technology to administer measurement tools before they undergo sound empirical development may exacerbate a perception that the measure is extremely valid, simply due to popular use or widespread distribution. Consequently, given the extensive reach of technology, its use could result in measures being perceived as more valid than they really are, consistent with recent criticisms of the empirical

validity associated with the Driver Behaviour Questionnaire (af Wåhlberg et al., 2011; af Wåhlberg, 2009).

Consequently, there are still major challenges for researchers to firstly identify the saliency of potential factors that influence work driving behaviour and secondly to incorporate these concepts into valid and reliable risk assessment measures capable of accurately predicting crashes and traffic offences in work driving settings.

Objective 4 – Investigate the ability of a newly devised self-report work driving risk assessment measure to predict crashes and offences within the light vehicle fleet context.

Paper Five (Chapter Eight) reported on a study using a newly devised risk assessment measure which incorporated items representing subscale concepts from existing self-report measures, along with a number of new items designed to assess organisational and contextual influences on work related driving behaviour. Along with achieving objective four, this study was undertaken to answer the third and fourth research questions underpinning this program of research:

Can environmental, organisational and driver related factors that influence work related driving predict crashes and offences within a fleet environment?

Can a newly devised work driving risk assessment measure identify risky drivers by predicting crashes and traffic offences within the Australian work driving context?

In order to answer these questions, the new measure included concepts that were identified in the proceeding studies and were consistent with the various levels of the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007). The additional items included in the new measure assessed issues such as time pressure, distraction, casualness, awareness, maintenance, fatigue and experiences of minor damage. Logistic regression analyses were performed to determine the predictive ability of this measure for both work related driving offences and crashes and non-work related driving offences and crashes.

The key finding emerging from this study was that although collectively the factors assessed by the measure were significantly associated with crashes and traffic offences, the measure possessed little ability to accurately predict these outcomes. Additionally, in this study, contrary to previous research results (Davey et al., 2007;

Freeman et al., 2008), driving exposure (kilometres travelled) was also not a significant predictor. However, while this finding is inconsistent with previous research, it is acknowledged that the results obtained may simply be confirming the difficulties associated with using self-report measures to assess driver behaviour and related negative outcomes like crashes and offences.

Notwithstanding this limitation, these results do indicate that despite incorporating items within a newly devised self-report measure designed to measure a wider range of influences on driver behaviour, the measure proved to be no better than the existing ones examined in the program of research that incorporated even fewer constructs. In addition, despite the measure incorporating a range of additional factors consistent with the various levels of Stuckey et al.'s, (2007) Occupational Light Vehicle Use Systems Model, it appeared to possess no greater utility than the existing measures examined.

Consequently, in regard to the fourth objective of this thesis, the results demonstrate that the newly devised work driving risk assessment measure failed to meaningfully predict crashes and offences within an Australian work vehicle fleet setting. In regard to the third research question, the results also demonstrated that the environmental, organisational and driver related factors incorporated within the newly devised measure failed to predict crashes and offences within the fleet context. In addition, the newly devised self-report work driving risk assessment measure failed to identify risky drivers by predicting crashes and traffic offences, providing an answer the fourth research question. While these results were disappointing, there are a number of implications that arise from these findings that can directly inform the future development of assessment measures. These will be discussed in detail in the next section of this chapter.

Overall Aim - Contributing to the safety of work related drivers by developing and testing a new driver risk measurement tool for use by organisations.

A vast amount of research has consistently demonstrated that predicting human behaviour is extremely difficult for a variety of reasons (Robbins et al., 2011). For instance, according to Ouellette & Wood (1998), while it is widely accepted that the frequency of past behaviour is the best predictor of future behaviour it can also be argued that the measure of past behaviour is merely a proxy measure for a range of

complex psychological factors that results in consistent responses across settings and time (Ouellette & Wood, 1998). More broadly, difficulties in predicting human behaviour relate to a wide range of reasons, such as: the diversity of the human race or individual differences (Robbins et al., 2011), inherent difficulties measuring an array of constantly changing interacting factors such as situational circumstances, environmental and individual characteristics (Cziko, 1989); self-assessment bias (Diekmann, Tenbrunsel & Galinsky, 2003); and inaccuracies and limitations associated with research methodologies (Dawes, Faust & Meehl, 1989). Despite these difficulties, researchers continue to focus on developing better tools and methodologies to improve actuarial risk assessment methods. This is evidenced across a variety of settings such as: work related driving (Dorn et al., 2010); organisational behaviour (Robbins et al., 2011); consumer behaviour (Camerer, Loewenstein & Rabin, 2004); organisational citizenship (Davila & Finkelstein, 2010); and risk taking (Szrek Chao, Ramlagan & Peltzer, 2012). Arguably, the difficulties associated with developing valid and reliable assessment tools to predict human behaviour can be no more clearly highlighted than in the field of forensic psychiatry and psychology. While a plethora of actuarial tools that attempt to predict future acts of violence among the prison population have been developed over the past 50 years (e.g., PCL-R, HCR-20), these widely used tools continue to demonstrate limited results across various populations in identifying those most likely to commit future acts of violence (Gray, Taylor, & Snowden, 2011) . Nevertheless, the significance of the problems combined with the potential benefits of developing such tools will ensure that on-going attempts are made to: (a) establish better predictors of human behaviour; and (b) improve the knowledge best associated with methods to explain human behaviour.

Notwithstanding the unexpected findings that emerged from the current program of research, it has contributed to enhancing knowledge into the development of self-report work related driving risk assessment measures by firstly, assessing the capabilities of commonly utilised self-report measures such as Driver Behaviour Questionnaire (Reason et al., 1990), Driver Attitude Questionnaire (Parker et al., 1995); and the Safety Climate Questionnaire (Glendon & Litherland, 2001) to predict risky driving outcomes within various Australian light vehicle fleet settings.

Importantly, the results of Studies One and Two provided much needed evidence as to the distinct lack of ability of these measures to accurately predict crash and offence outcomes in the light vehicle fleet arena. The poor predictive ability of these measures is surprising, given that each of these measures assess factors commonly thought to be associated with crash outcomes such as driver error and speeding, which are commonly addressed through road safety campaigns (Australian Transport Council, 2011). Furthermore, items within each of these measures, such as driver behaviour; work pressure; perceptions and legislation are incorporated within the potential factors of influence conceptualised by Stuckey et al. (2007), and contained within the various levels of the Occupational Light Vehicle Use Systems Model.

On the other hand, apparent shortcomings of both existing and revised measures may simply highlight the inherent challenges involved in assessing the wide range of influence on work related driving as illustrated by the broad scope of the Occupational Light Vehicle Use Systems Model. For instance, although Study One utilised three common measurement tools; the Driver Behaviour Questionnaire (Reason et al., 1990); Driver Attitude Questionnaire (Parker et al., 1996); and the Safety Climate Questionnaire Modified for Drivers (Glendon and Stanton , 2000; Wills et al., 2005), each of these scales only comprises between three and five subscales. In regard to enhancing knowledge of risk assessment measure development, although these scales are popular in research, with respect to their application toward risk assessment, they fail to incorporate many other potential influential factors associated with safe driving within the work context.

In the initial stages of the research program, the limited ability of these tools to predict crashes and offences was hypothesised to be as a consequence of being antiquated and not incorporating a wide enough range of issues relevant to current occupational driving safety. Consequently, the second stage of this research aimed to expand upon the previously designed measures by obtaining drivers' perceptions regarding what they believe influence their work driving behaviour with a view to utilising this information in the further development of a new work driving risk assessment measure. Unfortunately, although a range of additional potential influences were identified and subsequently incorporated into the new work driving risk assessment measure, this measure proved to be no better than the previous ones in reliably predicting crashes and offences in a work setting. Nonetheless, the results

obtained from the second stage of the research contribute to enhancing knowledge into the development of work related driving risk assessment measures by demonstrating that the inclusion of numerous other contributing factors to crashes identified in previous research (Wills et al., 2006; Salaminen & Lahdeniemi, 2002; QFleet, 2010, Mitchell et al., 2012; Haworth et al., 2000; Wishart et al., 2007) and aligned with those outlined within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007), was not sufficient to enhance the predictive utility of the measure, at least in terms of predicting crashes and offences.

In addition, although the overall results of this research program could lead one to potentially question the overall validity and future use of self-report measures within the work driving risk assessment context, it is suggested that they be viewed as evidence attesting to the difficulties and complexity associated with risk assessment of work related driving in organisational settings. For example, although risk assessment within organisations is endeavouring to address various deficiencies in their systems and processes such as crash reporting and recording (Wishart et al., 2011; AFMA, 2008b), the use of outcome measures of crashes and traffic offences is not without limitations, particularly as not all unsafe driving specifically results in a crash or traffic offence in every circumstance. Self-report measures, in order to be valid and useful to industry as risk assessment tools, will require further refinement to better reflect meaningful outcome measures of driver behaviour, in contrast to just meaning crashes and traffic offences. More specifically, these 'better' outcome measures may need to focus on other aspects of or outcomes of aberrant driving behaviour, in contrast to relying on measuring crashes and offences, which could be potentially considered as random events. For example, effectively assessing driver behaviours known to contribute to increased risk may require the combination of a variety of measures such as; in vehicle technology, observations and self-report information regarding organisational processes. A full discussion of these potential outcome measures will be outlined within the future research section of this chapter (see section 10.4).

Notwithstanding the limitations associated with the lack of predictive ability outlined above, there is an important contribution to enhancing knowledge derived from the contrasting of results in Studies One and Two utilising the Driver Behaviour Questionnaire (Reason et al., 1990). More particularly, in Study One, driver error

was associated with crashes, whereas in Study Two it demonstrated a lack of significant contribution. While an underlying premise of the Safe System Approach in general road safety is that drivers will make errors and that the system needs to be designed to reduce the consequence of these errors (Australian Transport Council, 2011), the inclusion of specific items in this study to assess factors such as fatigue and distraction in the measure appeared to negate the impact of driver error. This suggests that drivers may simply attribute crashes to error, unless other potential factors are offered as options. Although speculative, the seriousness of this implication within a vehicle fleet setting and subsequent research in this area should not be overstated as the attribution of crashes within a work environment to driver error does little to enhance knowledge of specific problem behaviours.

Interestingly, within the theoretical framework conceptualised by Stuckey et al. (2007), relating specifically to work driving and light vehicle use, driver error is not identified as a potential determinant of crashes and injuries. Rather, the model conceptualises a wide range of factors that may contribute to driver behaviour. Consequently, future research into the development of risk assessment measures within the work driving setting may wish to reconsider the inclusion of driver error to explain crashes, instead incorporating various other underlying factors conceptualised and contained within the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007).

Alternatively, given that driver errors are a cornerstone of the Safe System Approach, future research could investigate enhancing the Occupational Light Vehicle Use Systems Model (Stuckey et al., 2007) by incorporating an error based factor within the theoretical framework. For example, errors maybe one type of intermediate outcome influenced by the various factors identified in the model, which in turn influence the overall likelihood of negative events like crashes occurring. In addition, this research could also explore driver attribution of error and potential relationships between errors and other underlying work and organisational factors such as those within the Occupational Light Vehicle Use System Model.

Consistent with other recent research directions (Dorn et al., 2010), progress toward improving the development of self-report work related road safety risk assessment measures within the Australian organisational work context may need to consider adopting a more tailored approach to the specific context of each

organisation. In other words, self-report measures, rather than contain broad concepts thought to be consistent across many organisations, may need to be developed to incorporate specific concepts associated with each individual organisation. For example, self-report measures used within this program of research were developed to incorporate a variety of concepts believed to influence work driving behaviour. Some of these concepts were developed and subsequently incorporated from previous risk assessment measures; others were derived from previous research and relevant literature and some from earlier studies within this current program of research. Consequently, the self-report measures utilised did not contain situational or organisational specific items unique to each organisation. For example, although questions were asked regarding how frequently respondents drove when feeling fatigued, they were not assessed on their knowledge of their organisation's fatigue policy. In order to adopt a risk assessment approach which better understands and predicts driver behaviour, consideration needs to be given to how self-report risk assessment measures could be tailored to assess the current state of affairs in each specific organisation. In other words, drivers within work settings are expected to comply with policy and legislation but in risk assessment processes using self-report measures, it has not been established that drivers within the organisation are familiar with the policies or legislation in order to be able to comply, nor what effect these policies have on subsequent driving behaviour.

A further contribution of the results to enhancing knowledge in this field is evidenced in Chapter Seven which explained Australian fleet drivers' perceptions of what influences their work driving. An important result obtained from this study was the identification of a bi-directional influence of a number of factors. In particular, the results indicated the potential for certain road safety features designed to improve roads and in vehicle technology designed to create safer vehicles, to have both potentially positive and negative affect on different drivers' actual work driving behaviour. In other words, some drivers reported that particular safety features actually increased their perceptions of being safe consistent with risk homeostasis theory (Wilde, 1994; 2001) and that they consequently adjusted their driving behaviour in a less safe manner. In contrast, other drivers reported that poor road conditions or vehicles perceived as less safe would encourage them to adopt safer driving behaviours. The implications of these results for future risk assessment

measure development suggests that researchers may need to question assumptions associated with work related road safety item development and subsequent conclusions. For example, researchers need to be mindful that while overall, drivers will be safer in the event of a crash if they are driving safer vehicles, these modern vehicles may also influence drivers to adopt risker driving behaviours through their perceptions of feeling safer and consequently adjusting their behaviour according to the amount of risk they are willing to accept (Wilde, 2001). In addition, traditional self-report measures such as the Driver Behaviour Questionnaire (Reason et al., 1990), Driver Attitude Questionnaire (Parker et al., 1995), and Safety Climate Questionnaire (Glendon & Litherland, 2001), primarily incorporate items reflecting unsafe driver behaviour. Future measures incorporating questions relating to the type and features of vehicles may also benefit from including items associated with perceptions of risk associated with the vehicle safety features.

Finally, in regards to development of self-report work driving risk assessment tools, the measures used within this research contained items, that for instance, asked respondents to provide an indication of the frequency of risky driving behaviours such as speeding, fatigue, and mobile phone use, in contrast to incorporating items that asked respondents about the manner in which management addresses these issues. Although self-report measures like this provide an indication of the prevalence of these risky or illegal activities, they do not necessarily reflect the extent of organisational risk management processes designed to reduce the frequency of these behaviours. Given the potential impact of organisational influences on subsequent work driving, this may be an area for future research development.

In summary, this program of research has contributed to enhancing knowledge into the development of self-report work related road safety risk assessment measures within the Australian organisational work context in a range of ways. Firstly, it provided evidence as to the limited ability of previously designed measures to accurately predict risky driving outcomes as measured by self-reported crashes and traffic offences. Secondly, results obtained in the initial study utilising the Driver Behaviour Questionnaire (Reason et al., 1990) produced an overlap of items reflecting aggression and speeding, which suggests that these two behaviours, at least within the Australian fleet setting, may not be mutually exclusive behaviours. Consequently, the potential overlap between speeding and aggression has clear

implications for future driving risk assessment measure development. For instance, previously designed measures such as the Driver Behaviour Questionnaire have conceptualised these factors as separate and future research may need to further explore this association. In addition, the interrelatedness of speeding and aggression within a work setting may also have implications associated with future intervention development to reduce the prevalence of these behaviours.

Thirdly, the identification and inclusion of a range of items designed to reflect other organisational factors believed to influence work driving behaviours failed to enhance the predictive utility of the new measure. Fourthly, little empirical research has been undertaken utilising the Occupational Light Vehicle Use Systems Model, which identifies a range of potential determinants of injury and crashes within the work setting (Stuckey et al., 2007). This thesis has provided some research evidence regarding the model's value in guiding further research in the fleet context.

Finally, this research has provided evidence suggesting that there is limited value in future research to continue to use self-report measures in isolation, in regards to determining work driving risk. Certainly, if any future use of these measures is undertaken within a work driving risk assessment setting, that use should at a minimum, better establish improved validity associated with a variety of outcome measures such as observed driver behaviour, in-vehicle monitoring, and improved crash and incident reporting and recording (af Wåhlberg, 2009; 2011; Dorn et al., (2010). However, further research is also needed to validate these alternative outcome measures, details of which will be discussed in a section outlining future directions for research (section 10.4). However, before this, the strengths and limitations associated with this program of research will be discussed in detail.

10.3 STRENGTHS AND LIMITATIONS OF THE OVERALL PROGRAM OF RESEARCH

Despite the strengths and limitations of each particular study having already been mentioned within each of the published papers as a requirement of publication, the overall strengths and limitations of the program of research are discussed below.

Firstly, a particular strength of this research relates to the individual samples as well as the sample sizes. Within the Australian work driving setting, very little research that has been undertaken has utilised large sample sizes of active work

drivers. A number of individual organisations participated in the program of research. Therefore, results obtained across the six year time frame of research are representative of various organisations in contrast to just one. In addition, the samples obtained in each study were reasonably large and comprised employees who drove for work, and worked in a full time capacity. Therefore, the results obtained are likely to be robust and generalizable to a variety of vehicle fleets within the Australian context. Furthermore, considering the overall limited work related road safety research within the Australian context, this research is also particularly relevant.

Secondly, the use of a mixed methods design enabled insight into work driving risk not only in terms of quantitative analysis of self-report measures but also provided a unique insight (through qualitative analysis) into what drivers within Australian fleet settings believe influences their driving behaviour. Importantly, obtaining actual drivers' perceptions and the manner in which they believe these factors influence their behaviour, provides a unique perspective to guide future work driving risk assessment measure development.

A third strength of the overall research program relates to the use of the Occupational Light Vehicle Use Systems Model framework conceptualised by Stuckey et al., (2007). Since its development little research has utilised the model it in work driving settings, despite it being conceptualised specifically for the light vehicle fleet safety domain. While there are numerous potential determinants identified in the model, certainly too many to assess within the scope of this thesis, the results associated with some of the concepts applied provide support for the utility of the model in the work driving research setting.

Finally, a particular strength of this research program relates to the comprehensive multi-layered approach undertaken to assess self-report measures to predict crash and traffic offence involvement, before developing the new tool. More specifically, over the course of the research program, various widely implemented self-report measures were utilised before assessing a wide range of additional contextual items in subsequent measures. This comprehensive approach clearly indicates that the future research development of risk assessment measures needs to move away from single-source data methods (e.g., self-report data), as well as relying only on the use of crashes and offences as outcomes measures. Instead, future

research endeavours needs to define more appropriate lead indicators of risk assessment along with developing valid outcome indicators of work driving safety. In addition, further development of risk assessment measures needs to incorporate a thorough methodological approach to driver risk assessment by including other mechanisms of data measurement such as: in vehicle monitoring; observation and measurement of organisational risk management processes; adherence to policy and practice; and assessment of managerial processes dealing with unsafe driving. Each of these will be discussed in the next section relating to future directions.

In regards to limitations of the research, firstly this research program experienced difficulties associated with predicting human behaviour consistent with those outlined in previous research, which further highlight the complex interactions between people, vehicles, environment, and organisations (Stuckey et al., 2007; Robbins et al., 2011; Cziko, 1989; Diekmann, et al., 2003; af Wåhlberg, 2009). However, these difficulties were also compounded by the limitations associated in particular with self-report data. For instance, the use of self-report data as measures of both independent and dependant variables may result in common method variance whereby an association is shown to exist when, in reality, the association may be the result of particular items within a scale influencing other items or alternatively being a product of social desirability e.g., systematic measurement error (af Wåhlberg, 2010). Previous research has indicated that social desirability can influence self-assessment outcomes (Krumpal, 2013; af Wåhlberg, Dorn, & Kline, 2010). Certainly within this program of research, social desirability may have in part accounted for a lack of significant results across a number of the studies, especially as this program of research was a part of a larger program designed to improve driving safety within the participating organisations. Consequently, drivers may have been reluctant to provide a completely accurate indication of the extent of some of their risky driving behaviours, especially within their employment context.

Secondly, self-report of crashes and traffic offences is reliant on participants' subsequent memory recall of those past events. Across each of the studies in this research program, crash and offence rates were consistently low, with a small subsample of each study sample reporting having previously been involved in a crash or traffic offence. These low rates could have been in part attributed to low recall, with participants requested to indicate from memory the frequency of their own crash

involvement and traffic offences over a previous one or two year time frame. This limitation is consistent with previous research that has highlighted the problems associated with memory recall due to forgetfulness (af Wåhlberg, 2012; Maycock, Lockwood & Lester, 1991; Maycock & Lester, 1995) under reporting (af Wåhlberg, 2012) and discrepancies over extended time periods (Alonso, Laguna and Seguí-Gomez, 2006).

Thirdly, utilising self-report data relies heavily on subjective assessments of driving ability and behaviour. Previous research has indicated that individuals' own assessments of driving behaviour may not reflect more objective data (Boccara, Delhomme, Vidal-Gomel & Rogalski, 2011). For example, research has demonstrated over estimates of driving ability not only by driving test applicants in comparison to evaluations by examiners (Mynttinen et al., 2009), but also compared to "average drivers" (Challenge to Change Workshops, 2009; Delhomme & Meyer, 2004), and other dimensions associated with driving activities (Gregersen & Nyberg, 2002).

Fourthly, the accuracy of self-report data is dependent upon each participant's individual definition of a crash, which may vary widely. Certainly, within various contexts such as insurance, police researchers and medical professions, self-report bias and differences have been proven to exist (af Wåhlberg, 2009). The low rates of crashes reported in each of the current study's samples may also have been impacted upon by self-report bias with participants not counting a minor damage incident as a crash. Further research may yet demonstrate that the frequency of minor crashes, rather than rarely occurring major crashes, are the best indicator of at-risk drivers. A further factor contributing to participants potentially not counting minor damage incidents is that the measures administered within this research program did not define crashes, but simply asked participants to indicate their previous crash frequency over a given time frame. Further anecdotal evidence confirming this potential limitation was obtained in a discussion with participants in the workshops described in Chapter Ten. In this workshop, one participant questioned the researcher as to whether to count reversing incidents that resulted in minor property damage as a crash, as currently within their organisation unless an incident resulted in an insurance claim, it was not officially classed as a crash.

A fourth limitation of this research program arises from the difficulties associated with developing a comprehensive risk assessment measure, while maintaining ease of administration and measurement efficiency. For instance, there are difficulties associated with incorporating a range of items within a risk assessment measure to reflect as many potential influences on driver behaviour as possible, while still making the risk assessment measure conducive to being easily and efficiently administered within an organisational setting. From a practical point of view, when conducting research using questionnaires within organisational settings, there is certainly an overall reluctance from management and employees to allocate sufficient time from their working schedules to complete lengthy surveys. Consequently, each of the risk assessment measures may have been limited by being unable to incorporate the full range of potential factors that influence work driving behaviour. For instance, while the Occupational Light Vehicle Use Systems Model proposed by Stuckey et al., (2007) lists a vast array of potential influences within each level of the model, to include items assessing all these factors within a measurement tool would result in it becoming extremely lengthy and consequently likely to be resisted by industry. Therefore, within this research program, decisions were made to include those items that were believed to be most relevant to work driving behaviours, while many other ones reflecting various other influences were not incorporated in an attempt to reduce the length of measures for ease of acceptance and administration. As a result, many potential predictors of risky driving behaviour may have not been included.

A further limitation of this research is associated with the decision to rely on crash involvement and traffic offences to be the outcome measures of interest. Firstly, the use of crash involvement as an outcome measure could be potentially flawed since crashes are ultimately the outcome trying to be prevented, not all crash involvement can be directly attributed to only the actions of a particular driver, but rather could be as a consequence of other drivers (e.g., culpability) or a complex range of simultaneous events. For instance, in all crashes attended by police or those included in insurance records, a level of attributed "fault" is determined, such that in multi vehicle crashes a particular driver or vehicle is deemed the primary vehicle at fault. However within this current research, crash involvement was assumed to be an outcome indicative of a driver's poor driving. This assumption fails to accommodate

or account for attributed fault and consequently some crash involvement reported may not be as a direct result of that particular driver's behaviour, but rather other drivers or other contributing circumstances outside the control of the driver. Not surprisingly, the assessment measures cannot predict a crash that may result from someone else's driving behaviour. However, research has yet to ascertain the value of including culpability in driving assessment procedures (af Wåhlberg, 2009), nor whether the collection of such data would have predictive value given the issue of self-report bias.

Similarly, self-report traffic offences could also be considered a potentially limited indicator of risky driving behaviour, not only due to limitations of self-report data as outlined above, but also from the perspective that not all breaches of legislation directly result in a traffic offence. If, as previously discussed within the early chapters of this thesis, work drivers are prone to speeding, then it could be argued that although work drivers may receive traffic infringement notices, these notices may be heavily dependent upon enforcement practices, rather than solely driver behaviour. In other words, drivers may be breaching legislation constantly, but whether they receive a traffic offence may be more as a consequence of targeted initiatives by police within the community. In contrast, a driver not having received any infringements recently may not necessarily be due to not breaching legislation, but rather to not being caught doing so.

There were also limitations associated with the way that crash involvement was measured within each of the studies. For example, participants were requested to provide an indication of their self-reported crash involvement retrospectively for either a 12 month or 2 year period, depending on the study. The first two studies (Chapters Five and Six) utilised a 12 month period, however the study reported in Chapter Nine used a time frame of 2 years. The 2 year period in the latter study was chosen in an attempt to obtain higher frequencies of self-reported crashes. Even with the extended time frame, self-reported crash involvement was still considerably infrequent, which potentially may have contributed to the lack of reliability in predicting crashes. In addition, it should be noted that research is yet to determine the ideal time frame over which participants are asked to recall crashes, however this issue will be discussed further in the future directions in section 10.4.

A final limitation in this program of research that requires acknowledgement is that the research was undertaken solely within the Australian work setting, and consequently the results may not necessarily generalise to other countries. However, it should be noted that there are limited findings in any other research that suggests that the Australian setting is unique in terms of work related road safety.

10.4 FUTURE DIRECTIONS

This current research program has demonstrated that the self-report risk assessment measures used within this research did not accurately predict crashes or traffic offences across a number of organisational samples. Despite limitations associated within the current research, the results indicate that a range of complex factors appear to influence work driving behaviour. Future research is required to firstly investigate the complexities associated with factors influencing work driving behaviour, and secondly, to determine which factors exert the most influence on drivers to take risks while driving for work. For instance, the Occupational Light Vehicle Use Systems Model identifies a range of potential determinants of injury and crashes across five distinct levels that are proposed to influence driving within the work setting (Stuckey et al., 2007). However, the results obtained from this research program, in conjunction with the conceptualised model, fail to establish the strength of some of these influences nor the potential interaction between different personal, organisational and environmental factors. Research within the work related road safety domain could seek guidance in this area from that exploring safety culture, as previous research within other organisational settings provides an indication of the importance of the multiple dimensions of safety culture and their relationship with safety outcomes (Biggs, Banks, Davey, & Freeman, 2013; Bosak, Coetsee & Cullinane, 2012; Guldenmund, 2010; Garcia-Herrero, Marsical, Gutierrez & Toco-Otero, 2013).

Recent research has been highly critical of self-report data within the road safety domain and, in particular, measures such as the Driver Behaviour Questionnaire (af Wåhlberg et al., 2011; af Wåhlberg, 2010; 2009). In contrast, a recent meta-analysis of research utilising the Driver Behaviour Questionnaire was argued to demonstrate the overall strength of the measure in relation to with crashes (Winter & Dodou, 2010). While the debate will continue to rage over the validity of self-report data and related self-report measurement tools, there are a number of

possible directions for future research using this approach. Firstly, research could further investigate the validity of self-report data by examining the stability of self-reported driving assessment over time. For instance, studies using self-report driving assessments could be are undertaken at timely intervals over an extended time frame, such as two or three years, in order to assess the consistency of the participants' responses over time.

A further consideration to enhance self-report crash reporting tools would be to investigate the appropriate time frame over which participants are requested to report crashes retrospectively. This program of research comprised two studies (Chapters Five and Six) that asked participants to report crash and traffic offence involvement in the previous twelve months, which may have limited the number of crashes reported. Another study (Chapter Nine) included questions asking participants to indicate the frequency of crashes and traffic offences over the last two years. However, the overall results across all three studies indicated similar proportions of the sample (approximately 11%) reporting being previously involved in a crash (irrespective of the time periods). Given the overall lack of crash involvement within these samples, questions remain regarding the optimal time period to recall crashes. Therefore, future research could further investigate various time frames associated with crash involvement (and compare them to objective crash databases) to determine what time frame is most useful.

In regards to crash involvement, particularly within the work setting, future research may benefit from considering other aspects associated with crashes such as the involvement of single versus multi vehicles, vehicle movement and crash culpability in order to refine crashes as an outcome indicator. For example, the literature outlined within this thesis in Chapter Two provided evidence of the high proportion of "at fault" crashes within various organisational vehicle fleets (up to 73% of all reported crashes), suggesting that the majority of fleet crashes are due to activities associated with work drivers in contrast to other road users. However, despite such a high representation of "at fault" crashes, a proportion of crashes may also be in part contributed to by other parties or involve more than one vehicle. Therefore, as noted in the previous section, simply being involved in a crash may not necessarily be a valid indicator of actual risky driving behaviour. Future research utilising crash involvement should seek to improve the validity of data collection by

obtaining collateral information regarding circumstances surrounding crashes and ascertain crash culpability. This could assist in further exploring the predictability of risk assessment measures, strengthening the utilisation of crashes as an outcome variable, and increasing the validity of any future conclusions associated with crash involvement and risky driving.

While there are limitations associated with self-report data, which questions the use of self-report risk measures, other data sources (such as insurance records), and methods of obtaining data, are subject to various limitations as outlined within Chapter Four of this thesis. Therefore, to assist in better understanding work related driving, especially within the safety context, future research will need to investigate methods of coordinating multiple sources of data and explore processes to increase their validity.

For instance, it is suggested that future work related road safety research and risk assessment measure development may need to utilise in-vehicle technology to monitor both the vehicle and the driver. Within a fleet environment, in-vehicle monitoring systems have the potential for safety related information to be obtained along with indicators of driving behaviour (Toledo, Musicant & Lotan, 2008). Research utilising in-vehicle technology has demonstrated its efficiency in monitoring the driving behaviour of inexperienced younger drivers (Farmer, Kirley, & McCartt, 2010; McGehee, Raby, Carney, Lee, & Reyes 2007). A further advantage offered by in-vehicle monitoring systems for not only fleet applications but also research is the opportunity to store and download data and review data retrospectively especially as it relates to critical events such as crashes, harsh braking, or excessive speeding (Horrey, Lesch, Dainoff, Robertson, & Noy, 2012). The use of such in-vehicle technology data may provide an opportunity to better validate any future self-report measures of driving risk assessment.

However, in vehicle monitoring systems are not without their limitations, especially in regard to work driving settings. For example, to be effective within fleet settings, information obtained through in vehicle monitoring systems requires feedback to drivers regarding driving behaviours, however the effectiveness of this feedback is still subject to influences by managerial process, organisational culture, safety climate and disciplinary procedures (Horrey et al., 2012). Therefore, future research is required to investigate the most effective approaches and strategies for

providing feedback, along with establishing the type of information that should be provided to drivers to reduce unwanted and unsafe driving behaviours. In addition, research suggests that although in-vehicle monitoring and associated feedback can lead to an initial improvement in driving behaviour, the improvement is quite often not sustained over any great length of time (Toledo & Lotan, 2006). Therefore, future research is still required to explore the use of in vehicle technology and the impact of this technology on organisational culture, management processes and interactions associated with driving behaviour feedback and improvement of safe driving behaviours over extended timeframes.

In regard to in-vehicle technology itself, many systems developed rely on customised algorithms and predetermined threshold limits established by the vendors of such equipment, which consequently establishes different parameters depending on the make and model of the system implemented (Horrey et al., 2012). In addition, in some case study research involving vehicle fleets utilising in vehicle monitoring systems, the setting of such parameters by the technology developers in contrast to empirical research to establish the parameters (Wishart & Rowland, 2010, Wishart & Rowland, 2013). Further research is required to better establish appropriate in-vehicle monitoring parameters and their relationship to driving safety. To achieve this, researchers and technology developers will need to collaborate to enable research informed driving safety parameters to can be empirically established and tested.

In regards to future risk assessment development, research utilising in-vehicle monitoring technology needs to also establish normative baseline safe driving indicators, so that valid comparisons of driving and assessment of risk can be undertaken. For example, many in vehicle technology systems typically record vehicle information such as speed and braking along with G force thresholds (Horrey et al., 2012). However, further research is required to determine the link between such vehicle information and crash risk. For instance, research needs to establish whether within a fleet setting, driving slightly over or under the speed limit is the norm, and investigate whether drivers that speed more than the norm are actually those that are involved in crashes. Similarly, research is needed to determine whether drivers who brake more than others or exceed G force thresholds are at an elevated risk of crash involvement. Future research utilising in-vehicle monitoring systems is

therefore required to not only establish appropriate baseline information, but also to explore the parameters around the obtaining of this data, and subsequently investigate links between the obtained data and actual crash involvement. In addition, links between in vehicle technology and the application of this technology specifically within a work driving safety setting need to be further explored.

Given the limited results obtained by any of the measures used within this thesis, future research into work driving risk assessment tools may consider adopting a more comprehensive approach to assessing organisational influences. For example, rather than relying on an approach that primarily focuses on individuals and the subsequent assessment of the individual, a more comprehensive risk management tool may be required that incorporates processes consistent with an organisational audit approach as outlined in Wishart et al., (2011) and consistent with the approach suggested by Mitchell et al., (2012). For instance, each of these approaches advocate for assessment of organisational processes and procedures that impact not only on drivers but also on overall management of risk. For example, future risk assessment development may contain a measurement component that firstly determines whether the organisation actually has good policies and procedures in place to support driving safety. In addition, such a tool may also need a component that monitors not only whether employees adopt these policies and procedures but also assesses the consistency of managerial processes associated with enforcing these policies.

Development of future work driving risk assessment measures may also need to adopt a more tailored approach to each individual organisation, incorporating concepts that relate specifically to that organisation. Given the complexities associated with interactions between individuals, vehicles, and the environment, in conjunction with different organisational processes, management and the type of work undertaken, it is unlikely that one risk assessment measure will be all encompassing. It is suggested that a more complex risk assessment process in contrast to a single measure may be required. For example, a tailored organisational approach to work driving risk assessment may need to incorporate processes using data sources such as: self-report across all employee levels (management, drivers, support staff) to ensure consistency; observations of employee driving activities and pre start maintenance procedures; behind the wheel driving safety audits to identify poor driving habits; vehicle and driver monitoring systems, crash and incident data;

and assessment of employee knowledge of policies, procedures, road rules and risk mitigation procedures. A potential benefit of adopting such a comprehensive tailored approach is that the information obtained will provide a consolidated organisational driving risk assessment measure in contrast to trying to establish assessment of individual work driving risk.

Finally, future research is required to establish improved lead indicators of safe and unsafe driving behaviour, in contrast to a reliance on lag indicators such as previous involvement of crashes and offences (self-report or otherwise). This would address a major limitation associated with the current research program which related to the type of outcome measures (crash involvement and traffic offences) used as indicators of risky driving behaviour. For example, within the work driving setting lead indicators could include measures relating to adherence to safe driving policy and procedures, organisational culture, and real time monitored driving behaviour. The establishment of better lead indicators could also have positive implications for industry by providing proactive indicators of driving safety performance, thus encouraging organisations to actively manage risk and monitor overall organisational driving safety performance in contrast to addressing driving safety issues as a consequence of crash events.

10.5 CONCLUDING REMARKS

In conclusion, this current program of research has highlighted that self-report measures and the subsequent data obtained from their use demonstrate numerous shortcomings, despite this methodology continuing to be the most widely used approach to measure, and thus reduce, crash risk (af Wåhlberg et al., 2011). The Driver Behaviour Questionnaire has gained wide acceptance (af Wåhlberg et al., 2011) and it is the most commonly used driver behaviour self-report measure globally (Winter & Dodou, 2010). However, despite this popularity, the results from this program of research indicate that within the Australian work driving context, the Driver Behaviour Questionnaire, along with other self-report measures, demonstrate limited ability to predict risky driving behaviour.

In addition, this thesis (in endeavouring to develop a work driving risk assessment measure), adopted a “one size fits all approach” that attempted to develop individual driver assessment approaches, in contrast to organisational driving safety

processes and procedures. Given that this approach has consistently been demonstrated to have numerous shortcomings, considerable merit may yet be found in redirecting research efforts towards a more comprehensive organisational assessment approach. In particular, incorporating various components that specifically assess processes associated with work driving risk management at the organisational level may be of benefit. For example, attention needs to be given to investigating further links between safety culture and safety outcomes and assessing policy and driving safety procedures, management activities associated with driving safety, vehicle selection procedures, and corporate driver adherence to safe driving policy and procedures.

In addition, research into the development of more effective work driving risk assessment measures should utilise various sources of data such as in-vehicle technology, self-report, and official crash databases to ensure development of valid outcome measures associated with risky work driving activities. In regards to industry, crash data reporting and recording mechanisms will need to be significantly improved to ensure the comprehensiveness and accuracy of crash data. Taken together, only reliable evidence-based data will prove of value to attempts to better understand the origins of unsafe driving behaviours in fleet settings and to develop more effective interventions that have a clear impact on road safety.

This program of research has demonstrated that work related road safety is arguably a complex issue that involves constant interactions between humans, vehicles, the road environment, and the organisational context. It is apparent that many factors associated with these various interactions can contribute to crashes, and thus future scientific endeavours should include a holistic approach. In regard to work driving risk assessment measures, researchers need to better understand the range and strength and association between factors potentially influencing work driving safety outcomes. In addition, to ensure research results are generalizable and applicable to industry, future development of work driving risk assessment measures need to be underpinned by scientific rigour in order to improve the validity of work driving safety performance outcomes measures.

Finally, any significant advances towards the development of effective work related road safety risk assessment procedures will be heavily dependent upon strong collaborations between the research and industry sectors. Such robust links will not

only ensure new discoveries have practical relevance, but can easily be transferred to industry partners, which will ultimately determine whether improvements occur to work related driving safety.

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Appendices

Appendix A

Centre for Accident Research & Road Safety – Queensland
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CARRS-Q is a joint venture initiative of the Motor Accident Insurance Commission and Queensland University of Technology

Organisational Safety and Work-Related Driving

The Centre for Accident Research and Road Safety Queensland (CARRS-Q) at the Queensland University of Technology (QUT) and your organisation are jointly undertaking a comprehensive research program to address vehicle safety issues in your vehicle fleet.

A major component of this program is gathering vital information from all employees who drive a fleet vehicle to better understand the issues involved in vehicle fleet safety.

The questionnaire is strictly confidential and you need not answer a question if you consider it too personal. QUT will collate all responses from all surveys, and provide overall feedback only.

Your specific responses will remain anonymous. The questionnaire should take about 15 minutes to complete. Please take the time to complete this questionnaire and return the questionnaire in the envelope provided.

To ensure your confidentiality and anonymity all questionnaires are returned directly to researchers at QUT. Please do not put your name on the questionnaire.

INSTRUCTIONS

For each of the following questions please select the answer which best reflects your views and/or experiences.

Please indicate your answer by circling the number that corresponds most closely to your opinion or by writing your answer in the space provided.

Please return your questionnaire in the reply paid envelope provided within the next two (2) weeks.

Thank you for your assistance

FLEET DRIVER SAFETY QUESTIONNAIRE

*(**PLEASE NOTE: '<u>Driving for work'</u>** includes driving for the purposes of work-related tasks and **<u>includes driving between work and home</u>**)*

1.) How would you rate any changes in your overall ability since taking part in the driver training course? (Please **circle one number** from 1 = 'Decreased' to 5 = 'Greatly Improved' for each item)	**Decreased**	**Remained about the same**	**Slightly Improved**	**Moderately Improved**	**Greatly Improved**
As a result of taking part in the driver training course, my driving skills have:	1	2	3	4	5
As a result of taking part in the driver training course, my overall safety as a driver has:	1	2	3	4	5

In the following sections, you will be asked about the same issues that we looked at in the first questionnaire. In some areas you may have changed your views or experiences only slightly, and in other areas, there might have been quite a lot of change. We do need you to answer all the questions so that we have a direct comparison.

2.) Information about your work vehicle and work-related driving

How long have you been driving this vehicle as part of your employment at ….?	_____ Years (if 1 year or more) _____ Months (if less than 1 year)
Who owns the motor vehicle that you drive most often for work? *Remember: **driving for work** includes driving for the purposes of work related tasks and includes driving between work and home*	Operational vehicle (Tool of trade) ……. 1 Salary Sacrificed …….. 2 Novated Lease …….. 3 Own Car…….. 4
What type of motor vehicle do you drive most often for work?	Car/Sedan/ Wagon……... 1 4WD (Utes up 3.5t)… …… 2 Heavy 4WD……..…….. 3 Heavy Vehicle …… 4 Other (please specify _____) …….. 5
Does your work vehicle have the company logo displayed on it?	Yes …… 1 No …….. 2 Sometimes…….. 3

If so, have you ever removed the displayed company logo from your vehicle?	Yes ……..	1
	No ……	2
	Not Applicable / Logo cannot be removed …..…….	3
When driving for work, where do you do most of this driving?	Mainly city/suburban roads ……	1
	Both city/suburban and country roads ……..……	2
	Mainly country roads …….	3
	Mainly off road ……..	4
	Other (please specify _____)……	5

When driving for work, in which state or territory do you mostly drive?	NSW……..	1
	VIC…….	2
	ACT……	3
	SA……..	4
	WA…….	5
	NT……..	6
	QLD……	7
	TAS……	8
Approximately how many hours per week do you normally drive for work?	None ……	1
	1-10 hours …….	2
	11-20 hours ……..	3
	21-30 hours ……..	4
	31-40 hours……	5
	41-50 hours ……	6
	50-60 hours ……	7
	61 hours or more ……...	8
Approximately how many kilometres do you drive each year for work?	None .....……	1
	1 – 10 000 kms……...	2
	10 001 - 20 000 kms …….....	3
	20 001 – 30 000 kms ……...	4
	30 001 – 40 000 kms ……	5
	40 001 – 50 000 kms ……	6
	50 001 – 60 000 kms ……	7
	70 001 – 80 000 kms ……	8
	80 001 – 90 000 kms ……	9
	90 001 – 100 000 kms ……..	10
	100 001 kms or more ……	11

3.) Information about your vehicle usage	Never	Hardly Ever	Occasionally	Quite Often	Frequently	Nearly all the time
When driving a vehicle for work, how often in the last 6 months have you…						
Had to drive more than 8 hours in any one day	1	2	3	4	5	6
Had to drive more than 2 hours without a break	1	2	3	4	5	6
Had to drive more than 2 hours at the end of a work day (after	1	2	3	4	5	6
Approximately how often do you drive this vehicle outside of work?	1	2	3	4	5	6
How often do any of the following people drive this vehicle?						
Spouse/Partner	1	2	3	4	5	6
Dependents	1	2	3	4	5	6
Friends	1	2	3	4	5	6

4.) How much do you think the following practices apply to your organisation? (Please **circle one number** from 1 = '*Never*' to 5 = '*Always*' for each item)	Never		Sometimes		Always
Safety rules relating to the use of motor vehicles are followed even when a job is rushed	1	2	3	4	5
Safety rules relating to the use of motor vehicles can be followed without conflicting with work practices	1	2	3	4	5
Safety rules relating to the use of motor vehicles are always practical	1	2	3	4	5
Employees can express their views about fleet safety problems to management	1	2	3	4	5
Employees can discuss important driver safety policy issues with management	1	2	3	4	5
Employees are consulted when changes to driver safety practices are suggested	1	2	3	4	5
Fleet safety problems are openly discussed between employees and managers/supervisors	1	2	3	4	5
Changes to fleet safety procedures are effectively communicated to workers	1	2	3	4	5
Employees are told when changes are made to vehicles or vehicle maintenance procedures	1	2	3	4	5
Employees are encouraged to support and look out for each other	1	2	3	4	5
Safety policies relating to the use of motor vehicles are effectively communicated to workers	1	2	3	4	5

… continued from previous page **How much do you think the following practices apply to your organisation?**	**Never**		**Sometimes**		**Always**
When driving, employees have enough time to carry out their tasks	1	2	3	4	5
There are enough employees/drivers to carry out the required work	1	2	3	4	5
There is sufficient time to enable employees to drive safely for work	1	2	3	4	5
Travel time is taken into account when work schedules are arranged	1	2	3	4	5
Work problems that are out of my control can be dealt with in a way that does not affect driver safety	1	2	3	4	5
Time schedules for completing work projects are realistic	1	2	3	4	5
Workload is reasonably balanced	1	2	3	4	5
When changes in workload have been made at short notice they are dealt with in a way that does not affect driver safety	1	2	3	4	5
Our company ensures that safety procedures and rules relating to the use of motor vehicles are available to employees	1	2	3	4	5
Safety procedures relating to the use of motor vehicles are complete and comprehensive	1	2	3	4	5
Safety procedures relating to the use of motor vehicles match the way tasks are done in practice	1	2	3	4	5
Management are committed to maintaining safe motor vehicles	1	2	3	4	5
Driver safety is seen as important in this organisation	1	2	3	4	5
Management are committed to driver safety	1	2	3	4	5
Driver safety is central to management's values and philosophies	1	2	3	4	5
Employee concerns about fleet safety issues are taken on board	1	2	3	4	5
Management practices enable me to drive safely	1	2	3	4	5
Management expectations encourage safe driving	1	2	3	4	5

5.) For each statement below, how often has this kind of thing happened to you while <u>driving for work over the past 6 months</u>?

(Please **circle one number** from 1 = '*Never*' to 6 = '*Nearly all the time*' for each item) **Please note:** '***Driving for work***' refers to driving for the purposes of completing work-related tasks and ***includes driving between work and home***	**Never**		**Occasionally**		**Nearly all the time**
Attempt to overtake someone in front of you that you hadn't noticed to be turning in front of you	1	2	3	4	5
Stay in a lane that you know will be closed ahead until the last minute before forcing your way into another lane	1	2	3	4	5
Miss 'Stop' or 'Give Way' signs	1	2	3	4	5
Pull out of a junction so far that you disrupt the flow of traffic	1	2	3	4	5
Fail to notice that pedestrians are crossing in your path of traffic	1	2	3	4	5
Drive especially close to the car in front as a signal to its driver to go faster or get out of the way	1	2	3	4	5
Sound your horn to indicate your annoyance to another driver	1	2	3	4	5
Queuing to enter a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	1	2	3	4	5
Cross a junction knowing that the traffic lights have already turned against you	1	2	3	4	5
Whilst turning nearly hit a cyclist who has come up on your inside	1	2	3	4	5
Intentionally disregard the speed limit on a highway/freeway	1	2	3	4	5
Fail to check your rear-view mirror before pulling out or changing lanes, etc	1	2	3	4	5
Become angered by a certain type of driver and indicate your hostility by whatever means you can	1	2	3	4	5
Become impatient with a slow driver ahead and overtake on the inside	1	2	3	4	5
When overtaking underestimate the speed of an oncoming vehicle	1	2	3	4	5
Race away from the traffic lights with the intention of beating the driver next to you	1	2	3	4	5
Skid while braking or cornering on a slippery road	1	2	3	4	5
Drive even though you suspect you may be over the legal blood-alcohol limit	1	2	3	4	5
Intentionally disregard the speed limit on a residential road	1	2	3	4	5
Become angered by another driver and give chase	1	2	3	4	5

Drive while under time pressure	1	2	3	4	5
Find your attention being distracted from the road	1	2	3	4	5
Hit/bump/scrape something while manoeuvring (including parking and reversing)	1	2	3	4	5
Drive while tired	1	2	3	4	5
Save time during the day by driving quicker between jobs	1	2	3	4	5
Have difficulty driving because of tiredness or fatigue	1	2	3	4	5
Not wear your seatbelt	1	2	3	4	5
Find yourself nodding off while driving for work	1	2	3	4	5
Lose concentration while driving	1	2	3	4	5
Do paperwork or other admin while driving	1	2	3	4	5
Eat a meal while driving for work	1	2	3	4	5
Physically check behind the vehicle for objects before reversing	1	2	3	4	5
Find yourself driving on “autopilot” on the way home from work	1	2	3	4	5
Drive home from work after a long day (after working 12 hours or more)	1	2	3	4	5
Remove your seatbelt for some reason while driving	1	2	3	4	5
Drive while using a “handheld” mobile phone	1	2	3	4	5
Drive while using a ”hands free” mobile phone	1	2	3	4	5

6.) To what extent do you agree or disagree with the following statements? (Please **circle one number** from 1 = '*Strongly Disagree*' to 5 = '*Strongly Agree*' for each item)	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly agree**
Some people can drive perfectly safely after drinking three or more pots of beer in an hour	1	2	3	4	5
People stopped by the police for following too closely are unlucky because lots of people do it	1	2	3	4	5
I would welcome further use of double white lines to let me know when it is unsafe to overtake	1	2	3	4	5
Speed limits are often set too low, with the result that many drivers ignore them	1	2	3	4	5
It is quite acceptable to take a slight risk when overtaking	1	2	3	4	5
Close following isn't really a serious road safety problem	1	2	3	4	5
I know exactly how fast I can drive and still drive safely	1	2	3	4	5
Some people can drive perfectly safely even when they only leave a small gap behind the vehicle in front	1	2	3	4	5
Even one drink makes you drive less safely	1	2	3	4	5
I would favour stricter enforcement of the speed limit	1	2	3	4	5
Some drivers can be perfectly safe overtaking in situations which would be risky for others	1	2	3	4	5
Drink driving isn't really a serious road safety problem	1	2	3	4	5
The aim of the police should be to stop as many people as possible overtaking in risky circumstances	1	2	3	4	5
Even driving slightly faster than the speed limit makes you less safe as a driver	1	2	3	4	5
I would be happier if regulations relating to close following were more strictly applied	1	2	3	4	5
It's OK to have a few drinks before driving home after work at the end of the week	1	2	3	4	5
Even driving slightly too close to the car in front makes you less safe as a driver	1	2	3	4	5
The law should be changed so that drivers aren't allowed to drink any alcohol	1	2	3	4	5
The main aim of speeding fines is revenue raising	1	2	3	4	5
I think it is OK to overtake in risky circumstances as long as you drive within your own capabilities	1	2	3	4	5

7.) BEFORE ANSWERING THE FOLLOWING QUESTIONS PLEASE READ THESE DEFINITIONS:

*'**Crashes'*** - any incident involving a motor vehicle that resulted in **damage to a vehicle or other property, or injury**.

'Offences' - any incident for which you were fined **or incurred a loss of demerit points**. **This excludes parking offences**.

'*Driving for work*' includes driving for the purposes of work related tasks and includes driving between work and home.

During the past **12 months** how many **crashes** have you been involved in w**hile driving for work?** *Please circle the number corresponding to your response*	None …… One crash …… Two crashes ……... Three crashes …… Four crashes …….. Five or more crashes …	0 1 2 3 4 5
During the past **12 months** how many **crashes** have you been involved in **while driving outside of work in your own time (including while driving your own vehicle or a company vehicle)?** *Please circle the number corresponding to your response*	None …… One crash …… Two crashes ……... Three crashes …… Four crashes …….. Five or more crashes …	0 1 2 3 4 5
During the past **12 months** on how many occasions have you lost any demerit points or been fined for any traffic **offences while driving for work?** *Please circle the number corresponding to your response*	None …… One offence …… Two offences …….. Three offences ……... Four offences …… Five or more offences ...	0 1 2 3 4 5
During the past **12 months** on how many occasions have you lost any demerit points or been fined for any traffic **offences while driving outside of work (in your own time)?** *Please circle the number corresponding to your response*	None …… One offence …… Two offences …….. Three offences ……... Four offences …… Five or more offences ...	0 1 2 3 4 5

We would like to be able to match this questionnaire with your first one and any future research we may conduct. However, we do not want to be able to identify you. Please complete this information. It does not mean anything to us, but will allow us to match your questionnaires.	**<u>First 3 letters</u> of your Mother's surname before marriage (<u>Maiden name</u>):** ☐☐☐ **Mother's month of birth:** _____

***Thankyou** for your participation, **please return this completed questionnaire in the reply-paid envelope provided**.*

If you would like any feedback upon completion of the study or have any queries about your participation, please contact Dr James Freeman or Mr Darren Wishart at (CARRS-Q), QUT on phone 07 31 38 4677 or email je.freeman@qut.edu.au or d.wishart@qut.edu.au.